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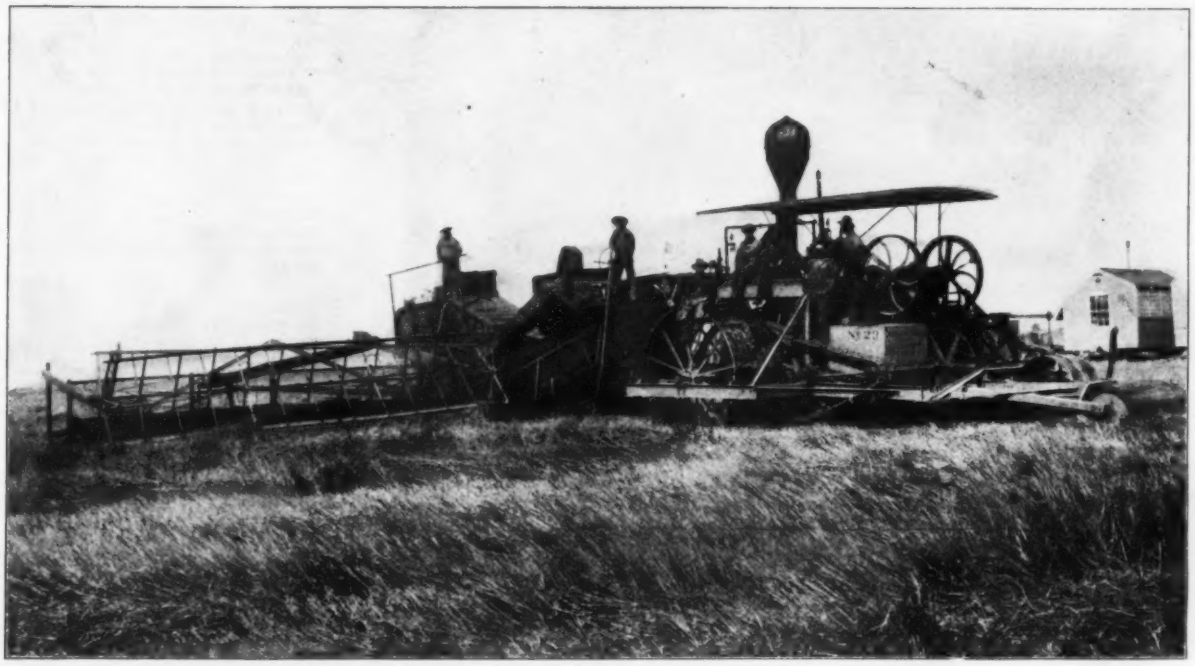


HARVESTING WHEAT IN CALIFORNIA WITH STEAM OUTFIT.

[Photographed by Mr. P. E. Holt.]

REAR VIEW OF STEAM HARVESTING OUTFIT, SHOWING METHOD OF DUMPING SACKED GRAIN.

[Photographed by Mr. P. E. Holt.]

WHEAT GROWING AND GENERAL AGRICULTURAL CONDITIONS IN THE PACIFIC COAST REGION OF THE UNITED STATES.*

By EDWIN S. HOLMES, JR., Division of Statistics.

INTRODUCTION.

THE wheat-growing region of the Pacific Coast is located in the States of California, Oregon, Washington and Idaho. The first impression made on the Eastern visitor by observation of the farming methods in vogue in this region is that there is a total difference between them and those to which he has been accustomed in the East. Everything relating to farming operations in this section, from the sowing of the seed to the harvesting of the crop, is at variance with the methods employed in his Eastern home, and he not infrequently makes comparisons in favor of what he terms the more economical and thrifty style of farming in his own part of the country; but, on closer investigation, he becomes convinced that Eastern methods and policies will hardly fit the conditions as they exist on the Pacific Coast. Methods which give the very best results in the East would often be totally worthless on the Pacific Coast, and consequently, owing to its peculiar natural conditions and resources, the Pacific Coast region has a farming system which is distinctively its own.

REAR VIEW OF COMBINED HARVESTER WORKING ON SIDE HILL.

[Photographed by Mr. P. E. Holt.]

SIZE OF FARMS.

In the first place, much of the agricultural land of the section is in large individual tracts, and although the tendency of the past twenty-five years has been toward a gradual reduction in the area of individual farms and ranches, they are still of a size much larger than the average farm of the East or even of the Middle West. This is particularly true in California, where ownership of lands in large tracts developed during the early days of American occupancy, and at a time when there was very general doubt as to the possibility of raising a crop except where irrigation was possible, and agricultural land values were, therefore, so low that it was very easy to acquire a large area of land at an almost nominal figure.

As the population increased more attention was paid to the raising of food crops, and it soon became apparent that in years of abundant rainfall a crop of grain was an exceedingly profitable investment, and, indeed, the yield was often so abundant that, at the prices then prevailing, the crop of one season not infrequently paid for the land and often enriched the owner as well.

At that time, as before stated, it was a comparatively easy matter to secure a large tract of land, and therefore there was no occasion for the Eastern policy of maximum production on minimum area, it being decidedly easier and less expensive to secure a large holding for a wheat farm or for cattle grazing than to thoroughly cultivate a single acre, and for this reason a considerable portion of the section was soon divided into large holdings.

For the last quarter of a century, however, other ideas have prevailed, and there has been a gradual tendency toward the diversification of crops and the disintegration of the large individual tracts; consequently, it is now possible to purchase good improved land in farms of reasonable size. Notwithstanding the fact, however, that the tendency has been toward smaller holdings, there are still vast tracts of extremely fertile land in this section which can be profitably handled only as large farms.

These lands in their natural state possess qualities of soil which render them adaptable to the growth of wheat and other cereal crops, the low prices for which make necessary the most economical methods of production, and, until the existing conditions are modified by the irrigation of these areas, permitting the cultivation of crops of a more profitable nature, it might not be remunerative to divide these holdings.

FARMING FOR SINGLE CROPS.

Another marked feature of this region is the farming of large areas for a single product. This is especially true of the wheat farms, where this cereal is raised exclusively, without fertilization except that which is naturally obtained by renewing the land by the process of summer fallowing. In this territory no good crops for rotation are available, and the limited precipitation of rain prohibits the planting of a fertilizing crop.

NON-PRODUCTION OF FOOD.

The non-production of household supplies on the farm and the consequent purchase of such commodities, often in a distant market at high prices, is another characteristic of the entire Pacific Coast region, although the tendency now is, as it has been for some years, toward a greater production of foods for home consumption.

FARM MACHINERY.

The use of machinery of great capacity, which means an economy of human labor, but which often means a waste of grain, is another distinctive feature of this region, particularly in the great valley areas of California. Everything in the machinery line has always been on a large scale. Plows are set in gangs, reapers and headers are built with cutting bars of unusual length, and every effort is made to combine several operations into one, thus enabling one man to plow and cultivate the greatest possible area of land with as many horses as he can control.

The broad level fields of the grain country, particularly in the great valley of the Sacramento and San Joaquin Rivers, favor the use of the most ponderous and complicated machinery; and this fact has led to the introduction of the combined harvester, by the use of which it is possible for three or four men to control the strength of twenty-four to thirty-six horses in cutting, thrashing, recleaning and sacking grain, the several operations being accomplished as rapidly as the horses can pull the machines over the ground.

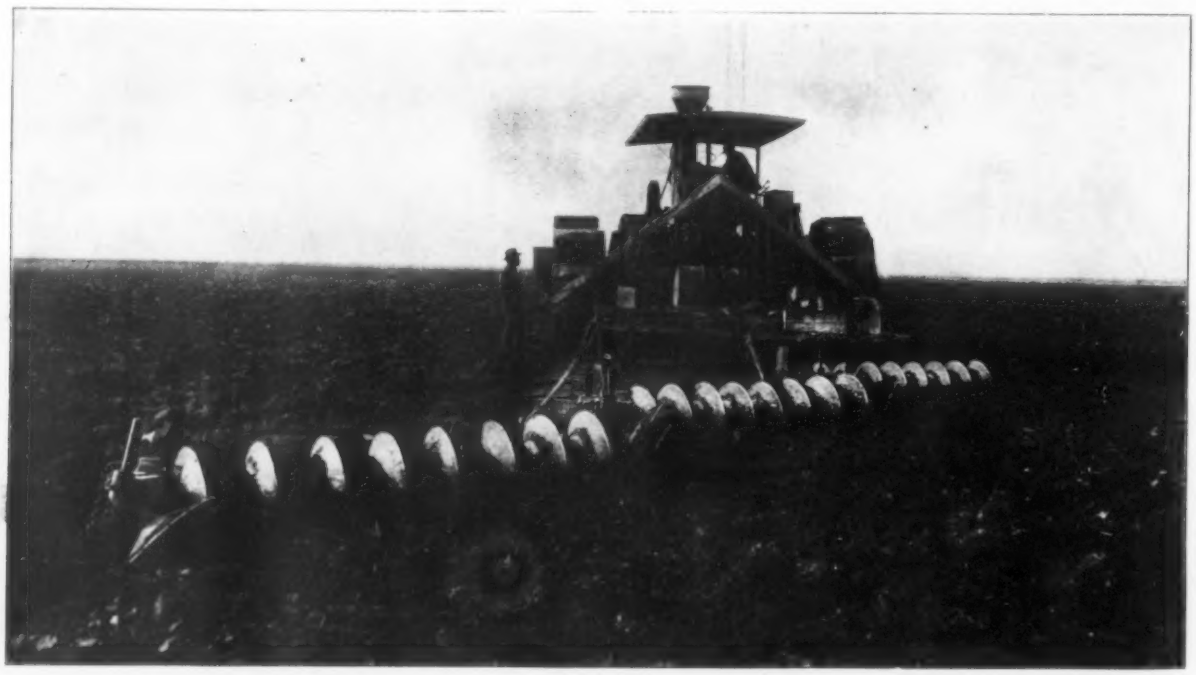
DISPOSAL OF STRAW.

The practice of burning the straw in the field, which is generally resorted to in many localities in this region, is made necessary by the fact that it cannot be plowed under and absorbed by the light soil, owing to the lack of sufficient moisture; and for this reason also it can not be rotted in the stack, while the scarcity of cattle precludes its use for feeding.

Burning also saves the ash ingredients for the land, and therefore aids in its fertilization. The nitrogen element is, however, unfortunately lost. At the same time the field is cleared of Hessian flies and other insect pests, which are, as a consequence, practically unknown in this section of the country.

FARM BUILDINGS.

The character of the farm buildings in the Pacific Coast region has greatly improved during the past few years, the homes in the section devoted to the cultivation of fruit showing the most marked improvement. In the matter of barns and outbuildings, there is still much to be desired, but it should be remembered that in a large portion of this country the climate favors an all-the-year outdoor life for farm animals, and although some protection is needed in the more northern portions, it will never be necessary or economical to erect such buildings as are essential to the welfare of stock in a climate where severe winters are the rule.



REPLOWING WITH STEAM OUTFIT IN THE GREAT VALLEY OF CALIFORNIA.

[Photographed by Mr. P. E. Holt.]

POPULATION.

This portion of country contained in 1890 a population of 1,955,672, of which 1,208,130, or 61.8 per cent, were in California; 313,767, or 16 per cent, in Oregon; 349,390, or 17.9 per cent, in Washington, and 84,385, or 4.3 per cent, in Idaho. On June 1, 1900, the aggregate

* Condensed from Bulletin No. 30, Miscellaneous Series, U. S. Department of Agriculture, Division of Statistics.

population of the Pacific Coast States had increased to 2,578,464, a total gain of 622,792 persons during the decade, amounting to 31.8 per cent.

California, the largest State in the group in both area and population, shows the smallest relative increase, having gained but 276,923, or 22.9 per cent, during the decade. Oregon follows, with an increase of 99,769, or 31.8 per cent. Washington comes next, with 168,713, or 48.3 per cent, and Idaho, by far the smallest State of the group, nearly doubled its population during the period, and shows an increase of 77,387, amounting to 91.7 per cent.

While the relative order of the States has remained unchanged with regard to population, the proportion of the total population of the Pacific Coast States represented by that of each State has changed considerably during the past ten years. California now has 57.6 per cent of the total, Oregon 16 per cent, Washington 20.1 and Idaho 6.3, California having lost slightly, Washington and Idaho both showing gains, and Oregon just about holding its own.

According to the returns of the Eleventh Census, there were in these States in 1890, 218,372 persons engaged in agricultural occupations. Similar data for 1900 are not yet available, and therefore an estimate based on the proportions existing in 1890 has been made, which, while it is probably not absolutely correct, is, nevertheless, sufficiently accurate for comparative purposes.

This estimate shows that of the 2,578,464 persons residing in this section of the country in 1900, 290,724, or 11.3 per cent, were engaged in agricultural occupations. They are distributed as follows: 152,805, or 52.6 per cent, in California; 57,945, or 19.9 per cent, in Oregon; 54,862, or 18.9 per cent, in Washington, and 25,112, or 8.6 per cent, in Idaho.

There are vast areas of unimproved lands capable of and awaiting cultivation in this section, much of which, while possessing qualities of soil and climate which render them especially adaptable to the production of fine crops, can be purchased at a comparatively low figure and on long time. The attention of immigrants and Eastern farmers has been attracted to these lands, and an increase in agricultural population has been the natural result. On account of the possible profit in the improvement of this uncultivated land, a growth in population during the next ten years even greater than that of the past decade would not be remarkable.

AREA DEVOTED TO WHEAT.

The Pacific Coast wheat region, as considered in this bulletin, embraces all of the wheat-producing lands of California, Oregon and Washington, and the northern portion of Idaho, which is practically a continuation of the great Palouse Valley. Methods employed in cultivating and harvesting wheat in this section are radically different from those in any other section of the country; in fact, even different sections of the Pacific Coast region have entirely different methods, both of tilling the soil and harvesting the crop.

VARIETIES OF WHEAT RAISED.

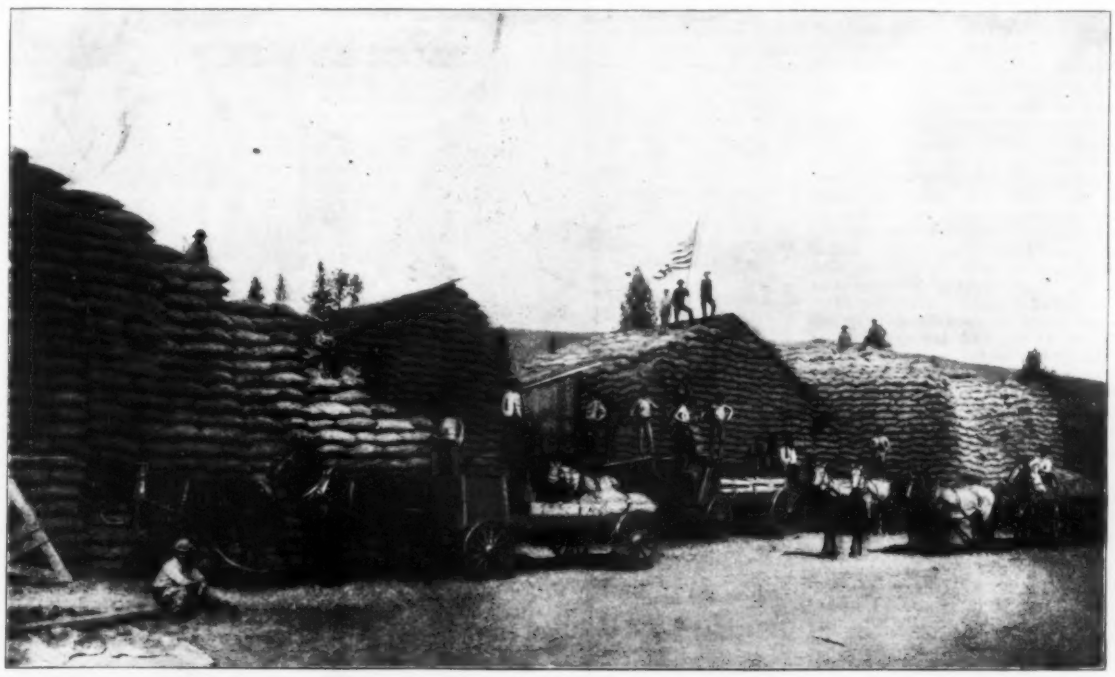
The varieties of wheat sown in this section are also entirely different from those of any other section of the country, their peculiar characteristics being a white grain, with a soft and starchy content; and conditions of soil and climate are such that even other wheats when imported for seed, although when originally planted entirely different in character from those of native growth, lose their individuality in a season or two and come to have practically all the characteristics of the standard soft white wheats of this region.

Introductions of other varieties, hard red wheat in particular, and in fact almost all of the hard wheat varieties, have been tried in this section, but it has been found that as soon as they become acclimated they partake largely of the characteristics of the native wheat of this section. The principal factor in producing grain of such character is probably the lack of humus in the soil, aided, no doubt, by the generally cool summers of this region.

A large proportion of the more common varieties peculiar to this region are of the Club Wheat group, so called on account of the peculiar club-like formation of the head. In California, Defiance and White Australian wheat are grown almost exclusively for milling purposes, and Sonora wheat for shipping. Red Chaff and Foise are the principal varieties grown in Oregon, and Palouse Blue Stem in Washington and Idaho. The ability of Club wheats to hold the grain and prevent shelling makes them especially desirable in this region of exceedingly dry summers, where the grain, after becoming fully ripe, is frequently left standing in the field for thirty to sixty days before being harvested.

BETWEEN THE WALLS OF 100,000 SACKS OF WHEAT AT MISSION, OREGON.

[Size of warehouse 56 by 310 feet; amount of wheat in sacks 250,000 bushels. Photograph furnished by Mr. Leo Peterson.]



SACKED WHEAT AWAITING SHIPMENT IN THE PALOUSE COUNTRY DURING THE WHEAT BLOCKADE OF 1897.

[Photograph furnished by the Spokesman Review.]

SEED REQUIREMENTS.

The amount of wheat required for seed varies greatly in different sections of the country, and there is also considerable variation in the time of sowing, winter wheat being sown from September to the middle of January, and spring wheat often as late as March 15. Late-sown wheat requires a very much larger amount of seed per acre than that sown earlier in the season, so that it not infrequently occurs that the sowing on farms in the same immediate locality will vary from 30 to 100 pounds per acre, and this great variation has rendered it practically impossible to make an accurate calculation of the amount of wheat sown per acre for the entire region; but it is probably somewhere near 70 pounds. This would indicate a total seed requirement of about 5,000,000 bushels, of which California uses a little more than 3,000,000 bushels, Oregon nearly 1,000,000, Washington about 820,000 and Idaho 121,000 bushels.

SUMMER FALLOWING.

Summer fallowing is generally practised all over

the entire region, largely owing to the fact that there is practically no rotation feasible. On a considerable portion of the area devoted to wheat in this section it is also impossible to grow a fertilizing crop to plow into the ground, as is the custom in the more humid sections of the country, as there is barely sufficient moisture for the staple crop.

The soil on the summer-fallowed land derives great benefit from the disintegration of its otherwise insoluble ingredients by the action of the air; but the chief benefit derived is from the rain of two seasons falling on the land on which one crop is to be produced. The greater portion of the wheat land of this region is capable of absorbing all the rain that falls, and the maintenance of a loose, clean surface as presented by the summer fallow prevents evaporation. In addition to this, early sowing gives the land a longer growing season, with the result that a good crop is nearly always raised on land which has been treated in this manner, even though the rainfall during the growing season is scant.

Summer-fallowed land is frequently sown in May of the season following its season of idleness; where pasture is needed, the cattle are allowed to graze on the young wheat during the entire summer season, and in the fall the final growth of wheat is allowed to start. Probably half the wheat land of the entire Pacific Coast region is summer-fallowed each year. This gives one crop on an average every two years, but if a sufficient amount of rain falls immediately after harvest it is possible to raise two crops in three years by reseeding promptly.

No fertilization of the wheat fields other than by summer fallow has been attempted except by individual farmers or in an experimental way by the State bureaus and experiment stations, the results of which experiments have not as yet been made public.

WHEAT HAY.

The greater proportion of the feeding material used for stock in this region is hay made from barley wheat, which is usually cut "in the milk" and cured in a manner similar to that used in curing the ordinary kinds of hay. It would be impossible to make an accurate estimate of the amount of wheat cut for hay, as it varies each year with the condition of the grain when at the proper stage to cut, and also with the price of hay and wheat. In a year of drought, for instance, when the wheat berry is shriveled and prospects for a crop of grain are not good, a very much larger proportion of wheat is cut for hay than would ordinarily be the case; or if the price of grain is exceedingly low, or the price of hay unusually high, the proportion cut for hay would be very much higher.

Considerable alfalfa is also used for feeding in this region, but it has been found that alfalfa alone will not suffice for the working animal, while wheat hay is often largely used without the addition of any other food, and with the very best results, as the partly grown grains in the heads of the wheat hay furnish all that is necessary in the way of grain food.

While, as before stated, it is not possible to make an accurate estimate of the amount of wheat ordinarily cut for hay, it is safe to say that probably 10 per cent of the entire wheat area of this region is usually devoted to that crop.

VOLUNTEER WHEAT.

A considerable amount of hay is often cut from wheat which has been allowed to "volunteer." It often happens that in the semi-arid regions that only a very small yield of grain will be secured, and if rain happens to come immediately after the harvesting of such a crop the farmer sometimes scatters a little additional wheat over the ground, without replowing, and allows it to grow as a volunteer crop. This crop is usually either pastured or cut for hay at the proper time. Not infrequently, however, the prospective wheat yield is sufficient to warrant its being allowed to mature as grain, and instances are not uncommon where yields have been as high as 25 to 30 bushels per acre on volunteer wheat lands.

IRRIGATION AND DIVERSIFIED FARMING.

The area devoted to wheat in this region will doubtless be gradually curtailed by irrigation, which, although as yet undeveloped, is rapidly becoming an important factor in farming in this section of the country. As soon as an irrigation plant has been introduced into a district and begins active operations, it becomes possible to diversify crops by the planting of garden truck and small fruits which would not grow in many localities in this section without irrigation, and thus the land rapidly becomes too valuable for the cultivation of wheat. Irrigation, however, thus far has been practically confined to semi-arid regions, and has not as yet had any appreciable effect on the wheat area of the region.

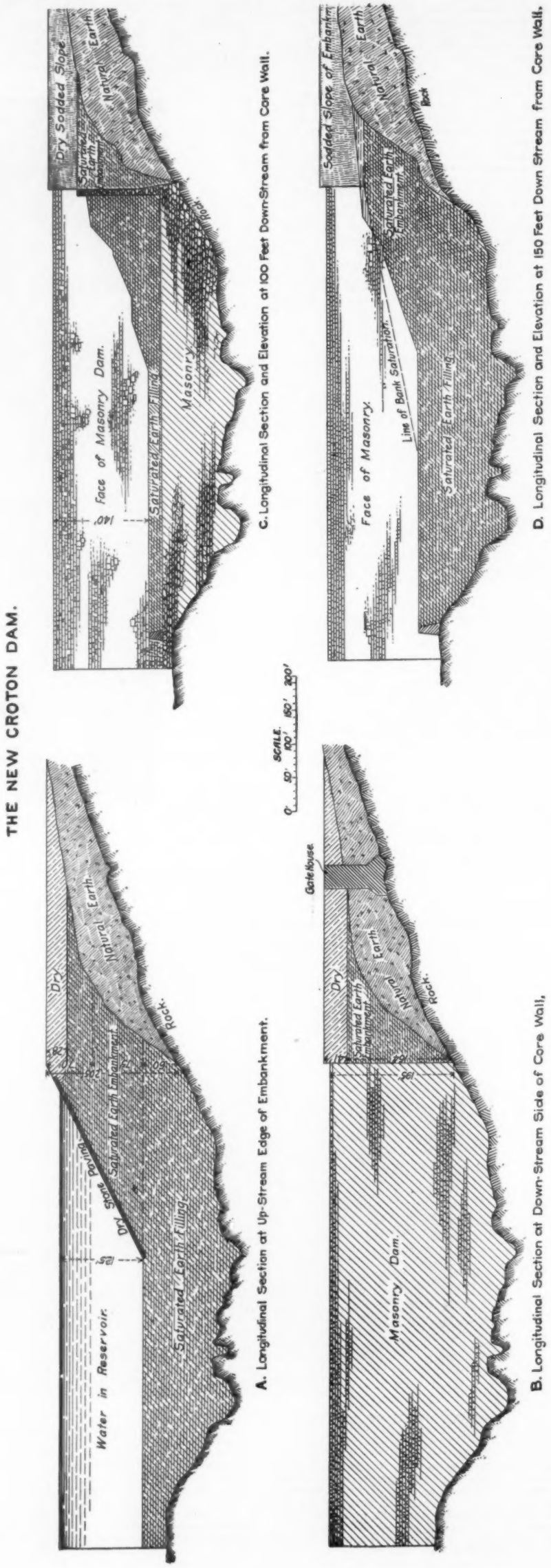
The chief factors in curtailing the area of wheat have been the introduction of fruit, particularly in the Sacramento Valley, and the attention recently given to dairying, which is rapidly gaining a strong hold in several sections of this region, notably in the Willamette Valley of Oregon, where wheat is being abandoned more rapidly than in any other portion of this region. The diversification of crops which naturally follows the introduction of irrigation will probably be extended in time even to the great wheat valleys of this region, where wheat has long been considered the only possible crop; but, as the more arid sections of the land will undoubtedly receive the first attention of the promoters of irrigation plants, it is not probable that the great wheat area of the Pacific Coast will be materially lessened by crop diversification for many years to come.

[Continued from SUPPLEMENT, No. 1353, page 21681.]

REPORT ON THE NEW CROTON DAM AND JEROME PARK RESERVOIR.

So far only the plans of this structure from an engineering point of view have been considered, that is to say, as regards the building of a structure which shall be reasonably secure against ordinary contingencies, at the least cost. There should, however, be precautions taken against extraordinary contingencies.

One such contingency which might arise is the occurrence of an extremely heavy rainstorm or cloud-


THE NEW CROTON DAM.
C. Longitudinal Section and Elevation at 100 Feet Down-Stream from Core Wall.
D. Longitudinal Section and Elevation at 150 Feet Down Stream from Core Wall.
Dry Sodded Slope
Natural Earth
Saturated Earth Embankment
Rock
Face of Masonry Dam.
Saturated Earth Filling
Masonry
Sodded Slope of Embankment
Line of Bank Saturation
Back
SCALE.
50' 0' 100' 200'
A. Longitudinal Section at Up-Stream Edge of Embankment.
B. Longitudinal Section at Down-Stream Side of Core Wall.
Gate House
Stone Paving
Water in Reservoir
Masonry Dam.

burst in the Croton Valley, or the failure of one of the large dams further up the valley, which might bring down a volume of water which the wasteway of the dam would be unable to carry off as rapidly as it came, and the dam would be overtopped, in which case the earthen embankment as at present planned, with the top at the same elevation as the top of the masonry dam, would be carried away. In the original design of the dam it was proposed to build the masonry portion of it to the elevation of 210 feet above tide, or 10 feet above the ordinary high-water level of the reservoir, and the earthen embankment was to be built 10 feet higher, that a wave of translation induced by a heavy landslide, the failure of a dam further up the stream, or a cloudburst, and which might easily rise to the top of the masonry, would have a vent over the masonry and not rise to the top of the earth embankment. It is true that the original plans, as shown on the drawings accompanying the contract, were defective in their provision against such a contingency, the earth and masonry dams being at the same elevation at their junction, the top of the core-wall being 10 feet lower than the top of the masonry dam and the earth embankment rising to its full height only at a distance of 100 feet from the junction. Preliminary plans for obviating this defect had been made but had never been approved by the Aqueduct Commission, and when, a year ago, the adjustment of the top line of the dam was finally made, the possible effect of such a wave of translation was disregarded, and, with the idea that a level crest for the whole length of the dam would present a better appearance when viewed from down the valley, the height of the whole length of the masonry dam was increased 6 feet and the height of the earthen dam diminished 4 feet, making the crest of the dam a level line from one end to the other at the elevation of 216 feet above tide level. The core-wall, too, was planned to be built 10 feet higher than before.

Both the original and the present plans are injudiciously designed, in view of the possibility, remote though it may be, of such an excessive flood. If any portion of the dam is to be made an earthen embankment, it ought to be constructed at least 10 feet higher than the crest of the masonry portion of the dam, and the masonry dam should not in any case be built higher than was originally designed. Such a change destroys the harmony and fitness of the design, which, having been scientifically determined, should be rigidly adhered to.

Another consideration which should be kept in view in the design and construction of this great work is rather æsthetic than of a purely structural character. We have here the most stupendous masonry structure of its class in the world. For nearly 1,000 feet of its length, no criticism as to its stability and permanency can be made. Then, solely from economical consideration, the design and the character of the structure are changed for a length of about 450 feet. This portion of the structure would not present an insignificant appearance in comparison with the main portion of the dam, if built in harmony with it, for it is, in itself, as it would appear above the surface, a higher and larger dam than any except a very few dams which exist elsewhere. The impression produced on the beholder by the present plan is that of a parsimonious makeshift not in harmony with the central portion of the dam nor with the massive spillway at the northern end, and would lead the general observer to inquire why so great an expenditure had been made on the ornamentation and architectural appearance of the central portion of the dam, instead of being applied to the creation of a massive homogeneous structure for the whole length of the dam, producing an impression of durability and stability which a composite arrangement of the kind proposed by either the original or the present plans does not inspire.

The absolute security of the dam against disaster, the architectural and æsthetic harmony of the structure and the general feeling of security in the public mind, would be satisfied only by the substitution of a masonry structure, similar in design to the rest of the dam, for the earthen bank proposed by the present plans.

We therefore recommend that the plan of construction of the southerly end of the New Croton Dam, from the end of the present masonry dam to the gate-house controlling the inlet to the old aqueduct, be modified so as to be in conformity with the plans for the masonry dam as originally designed and now in course of construction.

JEROME PARK RESERVOIR.

The Jerome Park Reservoir is an unfinished artificial basin intended for the storage and distribution of a part of the city water supply, extending from Kings Bridge Road between Jerome and Sedgwick Avenues northerly nearly to the south boundary of Van Cortlandt Park, a distance of about a mile, with an average width of about 1,500 feet and having a storage capacity of 1,800,000,000 gallons of water.

The surface it occupies was quite irregular, and to convert it into a reservoir involved the excavation and removal of large quantities of earth and rock and the erection of long sections of retaining embankments where the surface of the ground on the limiting lines of the reservoir was below the elevation at which it is proposed to carry the water in it; and it is relative to the method that was adopted in building core-walls for certain of these earthen dams or reservoir embankments that the Board's advice was asked.

The plans and specifications provide for lining the interior slopes of the embankment with a paving of stone or brick laid in concrete and its bottom with a layer of concrete, on good earth compacted by rolling, with the intention of making the entire interior surface of the reservoir impermeable to water.

They further provide for the construction of cement masonry core-walls in all the reservoir embankments.

For the section of the reservoir embankment extending across the south end of the reservoir and along its east side, a total distance of 2,850 feet, a core-wall has been built, of which over 1,200 linear feet are founded on earth and the remainder on rock.

The profile of the rock surface under the entire length of the core-wall is very irregular and is overlaid with a stratum of sand, the upper surface of which is approximately horizontal and about 20 feet below the top of the core-wall masonry, and extends thence down to the surface of the rock.

The question at issue is whether it is essential to the stability of the embankment and the security of the reservoir against dangerous leaks that these walls should in all cases be founded on the underlying rock.

The reservoir is evidently in a basin of the rock surface, surrounded by a ridge of rock, in which there are apparently some depressions through which water may drain to the north, the south and the east. The largest and most important of these depressions is at the north end of the reservoir. To this the attention of the Board was not called.

At the south end, adjacent to the Kings Bridge Road, at or near Station 76, there is an evident depression in the rock barrier, extending 20 feet below the bottom of the reservoir. The borings made indicate that this depression is filled with a fine sand which is saturated with water, is stable when confined and cannot run unless exposed to flowing water with a free outlet.

Under the embankment this depression is about 300 feet wide, and the core-wall built here does not extend down to the rock surface, being 30 feet above it at the deepest point.

The borings made in this vicinity indicate that about 100 feet south of the reservoir this depression is narrow, leaving a very contracted passage for the water which may tend to flow southward through the sand with which the depression is filled. The tests made show that the slope assumed by the water of saturation whether undisturbed or when its surface is lowered by pumping from a pit inside of the reservoir is northward and toward the reservoir, for about 60 feet outside of the core-wall. From that point the slope of the surface is toward the south. This change of direction was evident even after the water in the ground inside of the core-wall had been lowered 8 feet by pumping. The slope is very flat in each direction. The pumping for twenty-four hours from a pit inside the reservoir and 70 feet from the nearest test well seemed to lower the surface of the water, but not the slope at which it stood in the ground.

The plan of construction at this point proposes to make an embankment of selected earth, about 22 feet in height, on the natural surface and to line the inner slope of this embankment with a pavement of brick and stone laid in mortar on concrete and to cover the bottom of the reservoir with concrete laid on a surface of good earth well rolled. The embankment is to be 20 feet wide on top, with slopes of two to one.

Any breaks in the continuity of the reservoir lining can, at the worst, expose but a small area of the surface of the reservoir slopes and bottom to the action of the water it stores, and the character of the topography adjoining the reservoir boundary convinces us that no serious leaks need be apprehended under this section of core-wall founded on earth, and that none can possibly occur having a sufficient motion to threaten the stability of the embankment in which it stands. About 700 feet from the east end of this section of wall founded on earth, another depression in the rock surface begins, extending along Jerome Avenue 675 feet, where the wall is also founded on earth, its greatest depth under the wall foundation being 18 feet.

Along this section of wall founded on earth the rock outside of the reservoir is evidently, from all the borings which have been made, higher than it is under the embankment, and the natural surface of the ground nowhere within a distance of 500 feet outside of the core-wall is more than 8 feet below the water surface of the full reservoir. It was not considered necessary to make any test borings along the line of this wall.

About 600 feet further north than this section, near Station 99, is another like depression in the rock surface where for a distance of about 250 feet the core-wall is founded on earth, extending about 200 feet below the bottom of the masonry.

On this section the difficulty encountered in founding it indicates the presence there of a fine material which will run when exposed to flowing water.

The test pit and borings made near it show that the material in which this section of core-wall is founded consists of a stratum of very fine sand extending from a plane 6 or 8 feet below the natural surface of the ground down to the rock, similar to the thin strata of fine sand in some of the borings near the first section, tested at the Kings Bridge Road.

The topographical maps and the records of the borings in this vicinity indicate that the surface of the rock rises rapidly, outside this section of the embankment, and that the earth surface adjacent to the foot of its outer slope is nowhere more than 8 feet below the water surface of the reservoir. The accompanying diagram of the results of borings and pumping tests at Station 99 shows that the slope of the ground water, both before being disturbed by pumping from a pit inside the reservoir and after pumping also, is toward the reservoir.

It was found by numerous tests that all these fine sands are unstable when mechanically agitated in an excess of water, and that they all settle in a firm and compact mass under the water when the agitation ceases. They are quite unlike the true quicksands whose particles are of impalpable fineness and which are "quick" or unstable under still water.

The pumpage tests also indicate that there is no danger to be apprehended from any movement of these sands sufficient to affect the core-walls. The levels taken show the slope of saturation under the embankment at both Stations 76 and 99 to be in the direction of the reservoir and not away from it, as was supposed. It is evident that the ground water has not a free outlet to the south or east.

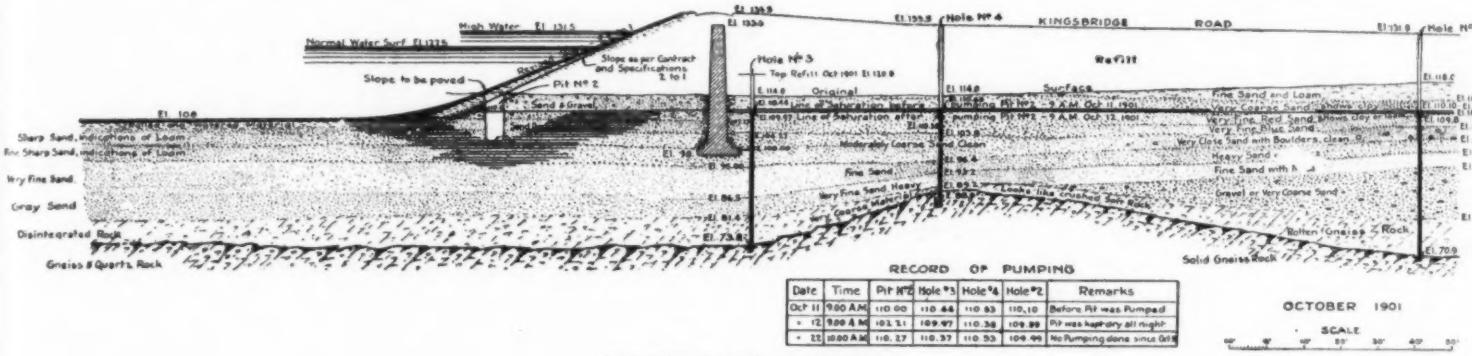
Only a small part of the embankment has been filled in along these core-walls, and they consequently produce a greater unbalanced pressure upon the fine saturated sand at their base than will exist there when the embankments are completed. No material settlement has thus far been observed in these walls, and it may be considered as not within the range of possibility that the foundation will yield under the completed embankments or that any material amount of water will find its way through or under them, if they are built in compliance with the specifications.

It must be borne in mind that the percolation of water through this bank cannot be rapid enough to induce any movement of the material, and that the access of water to the material will be almost absolutely cut off by the concrete lining of the banks and bottom of the reservoir.

To preclude all possibility of the sliding or slipping of the inner bank in case of the water being lowered rapidly in the reservoir, the Board finds that the inner slope of the reservoir bank should be made two and a half horizontal to one vertical, and that at the intersection of this slope with the reservoir bottom the interior lining of concrete should be made double the thickness that is provided for by the present plans.

The Board recommends that these modifications be made in the plans for the construction of the embankment on the south and east sides of the Jerome Park Reservoir.

The prompt action which the Aqueduct Commissioners have taken on this report and the faith which they have placed in investigating engineers are certainly praiseworthy.



RECORD OF PUMPING

Date	Time	Pit N°2	Hole °3	Hole °4	Hole °2	Remarks
Oct 11	9.00 A.M.	110.00	110.44	110.93	110.10	Before Pit was Pumped
" 12	9.00 A.M.	101.51	109.97	110.38	109.89	Pit was kept dry all night
" 22	10.00 A.M.	110.27	110.37	110.93	109.99	No Pumping done since Oct 8

OCTOBER 1901

SCALE

JEROME PARK RESERVOIR.

PRACTICAL EXPERIENCE REGARDING SICCATIVES.*

By E. EBELIN, Master Painter.

THE oldest drier is probably litharge, a reddish-yellow powder, consisting of lead and oxygen. Formerly it was ground finely in oil, either pure or with admixture of white vitriol and added to the dark-oil paints. Litharge and sugar of lead are to-day used only exceptionally as drying agents, having been displaced by the liquid manganese siccatives, which are easy to handle. The author, however, is of the opinion that the neglect of the lead compounds has not been beneficial to decorative painting. Where these mediums were used in suitable quantities, hard-drying coatings were almost always obtained. The author believes that formerly there used to be less lamentation on account of tacky floors, pews, etc., than at the present time.

Doubtless a proposition to grind litharge into the oil again, as of yore, will not be favorably received, although some old master painters have by no means discarded this method. It would probably pay a manufacturer to produce this preparation wholesale in the manner indicated. It would not only find buyers, but satisfy them as well.

Sugar of lead (lead acetate) is likewise used as a drier for oil paint. While we may presume in gen-

* Translated from the Deutsche Maler Zeitung.

eral that a siccative acts by imparting its oxygen to the linseed oil or else prepares the linseed oil in such a manner as to render it capable of readily absorbing the oxygen of the air, it is especially sugar of lead which strengthens us in this belief. If, according to Leuchs, a piece of charcoal is saturated with lead acetate the charcoal can be ignited even with a burning sponge and burns entirely to ashes. (Whoever desires to make the experiment should take 2 to 3 parts, by weight, of sugar of lead per 100 parts of charcoal.) This phenomenon demonstrates that the sugar of lead readily parts with its oxygen, which though not burning itself, supports the combustion. Hence, it may be assumed that it will also as a siccative, freely give off its oxygen.

Tormin reports on a siccative, of which he says that it has been found valuable for floor coatings. Its production is as follows: Pour 1 kilo of white lead and 1½ kilo each of litharge, sugar of lead and red lead (all lead compounds!) to 12½ kilos of linseed oil, and allow this mixture to boil for 8 to 10 hours. Then remove the kettle from the fire and add to the mixture 20 kilos of oil of turpentine. During the boiling, as well as during and after the pouring in of the oil turpentine diligent stirring is necessary, partly to prevent anything from sticking to the kettle (which would render the drier impure) and partly to cause the liquid mass to cool off sooner. After that it is allowed to stand for a few days, whereby the whole will clarify. The upper layer is then poured off and added to the light tints, while the sediment may be used for the darker shades. The author has quoted this recipe in full to enable manufacturers to produce a suitable lead siccative for floor coatings. This would cause the complaints regarding tacky floors, if not to cease altogether (for the oil may also be at fault), at least to become less.

If white vitriol (zinc sulphate or zinc vitriol) has been introduced among the drying agents, this was done in the endeavor to create a non-coloring admixture for the white pigments and also not to be compelled to add lead compounds, which, as experience has shown, cause a yellowing of white coatings, to zinc white. For ordinary purposes, Dr. Koller recommends to add to the linseed oil 2 per cent (by weight) of litharge and one-half per cent of zinc vitriol, whereupon the mixture is freely boiled. If the white vitriol is to be added in powder form, it must be deprived of its constitutional water. This is done in the simplest manner by calcining. The powder which feels moist is subjected to the action of fire on a sheet iron plate, whereby the white vitriol is transformed into a vesicular, crumbly mass. At one time it was ground in oil for pure zinc white coatings only, while for the other pigments litharge is added besides, as stated above.

As regards the manganese preparations, which are employed for siccatives, it must be stated that they do not possess certain disadvantages of the lead preparations, as for instance, that of being acted upon by hydrogen sulphide gas. The ordinary brown manganese driers, however, are very liable to render the paint yellowish, which, of course, is not desirable for pure white coatings. In case of too large an addition of the said siccative, a strong subsequent yellowing is perceptible, even if, for instance, zinc white has been considerably "broken" by blue or black. But there are also manganese siccatives or drying preparations offered for sale, which are colorless or white and therefore may unhesitatingly be used in comparatively large quantities for white coatings. A pulverulent drying material of this kind consists, for example, of equal parts of calcined (i. e., anhydrous) manganese vitriol, manganous acetate and calcined zinc vitriol. Of this mixture 3 per cent is added to the zinc white.

Of the other manganese compounds, especially that containing most oxygen, viz., manganic peroxide, is extensively employed. This body is treated as follows: It is first coarsely powdered, feebly calcined and sifted. Next the substance is put into wire gauze and suspended in linseed oil which should be boiled slightly. The weight of the linseed oil should be ten times that of the manganese peroxide.

According to another recipe a pure pulverous preparation may be produced by treating the manganic peroxide with hydrochloric acid, next filtering, precipitating with hot borax solution, allowing to deposit, washing out and finally drying. Further recipes will probably be unnecessary, since the painter will hardly prepare his own driers.

In conclusion some general remarks on siccatives may be in place.

Unless for special cases driers should be used but sparingly. As a rule 3 to 5 per cent of siccative suffices; in other words, 3 to 5 pounds of siccative should be added to 100 pounds of ground oil paint ready for use. As a standard it may be proposed to endeavor to have the coating dry in 24 hours. For lead colors a slight addition of drier is advisable; for red lead, it may be omitted altogether. Where non-tacky coatings are desired, as for floors, chairs, etc., as well as a priming for wood imitations, lead color should always be employed as foundation, and as a drier also a lead preparation. On the other hand, no lead compounds should be used for pure zinc-white coats and white lacquering.

Advertising American Farm Machinery in Greece.—I send herewith a copy of a catalogue published in Athens in the interests of one of the large manufacturing establishments of America, and would call attention to the success achieved by this method of advertising.

The local agent of this company, in speaking of the business done in American agricultural machinery, says that four times as many machines were sold this season as last, in spite of unfavorable crop conditions, and he believes the coming year will establish a record for this country, in which the area of farming land is not extensive.

I would especially call attention to the need for American houses to be represented by industrious agents in the principal trade centers of Greece. The agents of European exporters are always on the field. In response to numerous inquiries, I am endeavoring to introduce a number of manufactured articles from the United States, which, I think, can find a good market here, and, once known, will become indispensable. With no one, however, to look after later details, and with no direct line of ships from America, the venture constantly hangs in the balance. Competent and reliable agents may be had in almost every trade center—men who are acquainted with English sufficiently for business purposes, as well as with French and Greek. They must, however, be shown that there is money for them in the venture without the possibility of risk, and in the larger places an amount ought to be set aside for advertising purposes. —F. W. Jackson, Consul at Patras.

LATE DEVELOPMENTS IN ORDNANCE AND ARMOR.*

By J. F. MEIGS, Esq., Ordnance Engineer, Member.

IN the past ten years the developments in armor plate have consisted in, first, the introduction of nickel in the armor; second, the adoption of the super-carbonizing process invented by Mr. Harvey; and, third, the perfecting of this super-carbonizing process by Krupp. Parallel with these improvements in armor plate, whose tendency, or rather the tendency of the latter two, has been to produce armor of very hard outside face, the velocities of projectiles have advanced. From a purely rational point of view this would appear to be unreasonable, because hard armor is best attacked by heavy projectiles, which, if the size and weight of the gun remains constant, would mean a lowering of velocities. In other words, hard armor which may be cracked is best attacked by heavy projectiles, and comparatively soft armor by light, fast-flying shot.

In the ten years under review the advance in the resisting power of armor has been very material. The advance made by the introduction of nickel and by the adoption of the Harvey surface-hardening process, which was brought in at about the same time, added probably quite 25 per cent to the power of armor plate of fixed thickness to resist penetration. The adoption of the Krupp process probably added another 10 per cent to the resisting power of armor plate, and also added very materially to its power to resist cracking. It is perhaps not too much to say that the armor of to-day has 40 or 50 per cent more power to resist penetration than that of ten or twelve years ago of the same thickness. Its power to resist cracking is very difficult to measure numerically. This power, however, is very greatly increased, as much because of the better methods of melting and forging large masses of steel, as for any other reasons. It seems now almost impossible to crack well-made armor plates under conditions approaching those usual in reception tests. Their surfaces are spalled for an inch or two depth, and the tough back of the plate is very resisting to cracking effect. In a word, when comparing the armored ship of to-day with the ship armored twelve years ago, say, with the same thickness, we find that the former has an enormous superiority.

The same degree of superiority is not found in the gun itself. The guns of a fixed caliber are longer and heavier than they were, and the powder is better than it was ten years ago, but, as stated, the gun itself, though shaped differently, has not improved from improvement in quality of material so much as armor plate. Ten years ago a 6-inch gun weighed about 11,000 pounds, while now it weighs from 17,000 to 18,000. The former gun gave barely 2,000 feet with the brown powder then in use, while the later gun, with its charge of smokeless powder, will give 3,000 feet or more, and thereby its energy is more than doubled. This, however, it will be noted, is largely because the gun is heavier than the old 6-inch guns. The advantage which is most marked in the past decade in ship's guns, or, to use the more general term, in guns of position—that is, guns that are not moved from the place where they are set—is in rapidity of fire. Not many weeks since an English ship of war fired eight shots from a 6-inch gun in one minute, at a range of about 1,500 yards, at a target 15 feet high, and struck it every time. Such a feat a few years since would have been thought impossible, and, in fact, many people with whom I have conversed will not believe what I have stated to be a fact, but the reports that I have read of it in the newspapers, which, of course, are available to anybody, are of such a nature that I myself believe its truth. No doubt the ammunition was close by, or it is possible that the ammunition supply arrangements may have been extremely good, and that the ammunition may have been brought from the magazine. This is unlikely, however, and in the statement that I have seen, this is not said to have been the case. The actual trial of how many complete rounds of ammunition can be delivered to each gun in a ship would appear to constitute as important a datum regarding her efficiency as her record on the measured mile. It would depend, of course, upon her structural arrangements and upon the skill of the ammunition passers.

No doubt, also, the ship's course was carefully selected in such a way as to blow the smoke away from the gun, for, although powder is now called smokeless, the heated gases coming from the gun render it impossible to aim properly until they have blown away, and, if blowing toward the firer, they would hurt his eyes so that he could not make good practice. We hear, also, of guns, whose projectiles weigh 350 pounds, being fired three or four times a minute. These things are no doubt true, in at least a limited degree, and constitute a very marked advance in gunnery, for, while it would not be possible to fire a 6-inch gun many minutes at eight rounds per minute, both because the crew would become exhausted and because the gun and other parts would heat, yet the fact that this can be done for a short time, when it becomes necessary, is a matter of great consequence. It appears that this end has been reached, principally, if not solely, by putting it into the hands of one man—namely, the firer, to do everything that is required to aim and fire the gun, without moving and without taking his eyes from the line of sight. He simply keeps the gun aimed all the time, and fires it whenever it is loaded and as quickly as it is loaded. The adoption of measures of safety whereby he, standing half way from the breech to the trunnion of the gun, and with his back to the breech block, cannot fire the gun unless the breech is properly closed and the man handling it out of the way, are details of manufacture which have been mastered.

While, of course, it is very difficult to say at what range modern ships will fight, yet it would appear that this matter must be settled before any conclusions can be reached with regard to the kind of guns to be placed in ships. For example, if the old "Pensacola," having ten smooth-bore 9-inch guns on her broadside, can choose her range, she is more than a match for the modern "Atlanta," of equal tonnage, carrying three 6-inch and two 8-inch breech-loading guns on her broadside. The ship that can control range can outclass the other. It is necessary to determine to what range ships will usually come before determining upon their batteries and armor.

There is much difference of opinion in regard to the range at which the modern gun is effective. Possibly this comes from a neglect to appreciate the circumstances of the use of the gun, rather than the accuracy of the gun itself. The gun is itself very accurate, but the circumstances of its use are much less so. The changes in velocity due to changes in powder, cause some variation in the range of the gun, but the greatest difficulty consists in the absence of correct knowledge of the range, and, in guns in ships, in the continual motion of the ship—both the rolling motion and the swing, when the ship is turning through an angle. My impression is that those who have witnessed a good deal of firing from guns in coast fortifications think that a ship would be in great danger from the guns of a fort in direct fire at 8,000 or 9,000 yards, and I assume that this presupposes that the range is accurately known, as it usually may be in a fort. I should think, however, that so great accuracy would be attained only when the firing is very deliberate, and when such elements as the muzzle velocity due to the powder in use are accurately known. In a ship gun, where the range is rarely accurately known, and where the ship is usually moving, accurate practice cannot be made at so great a distance as 8,000 yards. I think that most naval officers believe that with their guns, and in reasonably smooth water, they can make fair practice at 3,000 or 4,000 yards. My own belief is that this is too great an estimate. At 3,000 yards range a target 15 feet high, when a gun is rolling at an angular rate of one degree per second, which is a fair rate only, the prolongation of the line of sight of the gun would sweep across the freeboard of a ship 15 feet high, which would include all the vulnerable part of the ship, in somewhat less than one-tenth of a second. This is a period of time too small to be appreciated by a man's nerves, and, indeed, the accuracy of operation of the firing apparatus of the gun can hardly come within this limit.

It is usual to assert that naval guns stand in greater need of high velocity than land guns, in order that the trajectory may be flatter and the gunner independent of the range at great distances. At present, for practical purposes, the trajectory is a straight line—having regard to the height of the broadside of the ship—for about 1,500 yards in length. By insisting, however, upon what is now known as "power" in guns—that is, the use of elongated and fast-flying projectiles rather than those which approach a rounded form and move with lower velocity, much is necessarily lost in smashing effect. The shell charges become smaller and the mine effect of the shell becomes less, and the damage to constructions that are hit becomes less. The shot of the old-fashioned 9-inch smooth-bore guns weighed 90 pounds, while that of the modern 6-inch rifle weighs 100 pounds. For anything that it can penetrate the former constitutes a more dangerous projectile than the latter. Against the upper works of vessels the old round shot is by no means to be despised. This all arouses the question of what caliber of gun the designer of a warship will put in. He has a certain weight to put into battery, and the question comes to him at once: Having 100 tons to dispose in guns and gun carriages, shall it be put in so many 8-inch guns or in so many 6-inch guns? Roughly, the weights of guns vary with the cube of the calibers, and for every 8-inch gun you can have eight 4-inch. As the 4-inch gun fires a good deal faster than the 8-inch, the weight of metal and of bursting charge thrown by the battery of light guns would considerably exceed that thrown by the heavier ones. The weight of a single discharge from a battery of fixed weight, of any caliber, would remain about the same, of course. These, it seems, are the great tactical questions in regard to guns: First, having a fixed system of guns—that is, having guns of different calibers in which the dimensions are about proportional to the calibers, what size guns shall we use; and, second, there is the other question: Is the system right? That is, should 8-inch guns weigh what they do, or should they weigh more or less; or, to put it in another way, are we satisfied with present weights of guns, or do we want more velocity in a gun of fixed caliber, and are we willing to accept the increased weight that must be given to the gun to get this?

Much discussion is going on now in regard to the substitution of 7-inch and 7.5-inch guns for 6-inch guns on the broadside of battleships, and, while everybody must be desirous of increasing to the utmost the size of the guns, and, consequently, their destructive effect, it must be remembered that this inevitably makes the weight carried heavier, and in certain cases limits the speed of firing. It has been generally asserted that guns cease to be rapid-fire when increased beyond 6 inches in caliber. Even 6-inch guns must have their cartridges separate from the projectile, and, as the projectile weighs 100 pounds, it is about all that one man wants to put into a gun quickly when standing on the deck of a rolling ship.

Another matter of much interest just now, particularly in this country, is the disposition of the turrets in battleships. I had the opportunity last sum-

* Read at the ninth general meeting of the Society of Naval Architects and Marine Engineers, held in New York, November 14 and 15, 1901.

mer to go over the battleships "Alabama," "Kearsarge," and "Massachusetts," when lying in Newport harbor. It is not necessary here to describe the batteries of these three ships, as they are all known to you, but there was perhaps no sentiment aroused within me more clearly defined than that of sympathy with the various officers and boards that have been called upon from time to time to pass upon the batteries of these ships. Volumes could be written upon the subject, and no one can reach a conclusion without first forming a clear idea of what sort of combat these ships are most likely to be engaged in. As we do not know what this will be, it seems that no one can dogmatize on the subject, and that all that can be done is that the matter shall be determined according to our lights, and that thereafter we should hope for the best. In passing, however, it may be noted that American ships always, from the first, have been very heavily gunned, and that again and again this has been shown, when the time of trial arrived, to be of vital importance.

There are many minor improvements which have been introduced in the use of guns, as, for instance, the almost general adoption of telescopic sights, which give greater accuracy of fire, the use of electric firing, which fires the gun more quickly when the sights are on, the use of automatic ejectors for the primers, and improvements in fuses. Also, high explosives have come to be used very generally in shells. These explosives are usually of the picric acid order, but have not yet attained much acceptance in this country. Many believe that they are quite as safe in shells as the old black powder, and, as they certainly break shells into a larger number of parts than the older explosives, it would appear that they are certain to be adopted in time. Also caps have been used on the point of armor-piercing projectiles, and these are becoming universal. Many theories are advanced as to why they help a shot through an armor plate, but of the fact that they do so help it, there is no doubt whatever. It is said that they are least effective in oblique fire, and, while this may be so, it is yet a thing very hard to demonstrate, as the penetration of all armor-piercing projectiles falls off very quickly when the shell does not strike fairly point first. The cause of this seems to be largely that the whole back end of the projectile, upon striking a plate obliquely, is wrenched off, and the very second that a projectile, when striking an armor plate, begins to go to pieces, that second it is done for and its chance of doing any material harm to the armor becomes nil.

In no respect, perhaps, has greater improvement in gunnery been made in the last ten years than in the practically universal adoption of smokeless powder. At present, the pure nitro-cellulose powder is generally held to be much the best. Though smokelessness is usually put forward as the great advantage of the modern powder, yet the absence of solid residue in the products of combustion would appear to be the real gain in this regard. In the old powders about 40 per cent of solid residue was projected from the gun as uselessly as though its weight was in sand, while in the modern powder all or nearly all the charge turns into gas and helps to propel the projectile. On the other hand, the gas of the modern powder, particularly where much nitro-glycerine is used in making it up, as is the case in cordite, for example, is of very high temperature and scores and gutters the gun very badly. This is much less so with the nitro-cellulose variety, and with the latter, where moderate pressures are used—say, of 34,000 or 35,000 pounds—the scoring of the gun is not a very serious matter. The scoring of steel by hot powder gas is a most extraordinary phenomenon. If there is ever so little a channel through which the gas can escape the steel is washed out and disappears in a most wonderful way. As, however, the propelling power of powder depends upon the amount of gas given off and upon the temperature to which it is heated, it is desirable, of course, to use as high a temperature as we can. In other words, if the scoring and guttering of the gas could be controlled, the hotter it is the greater the velocity attained would be. As a matter of fact, however, when high pressures—say, 40,000 or 50,000 pounds—are reached, the destructive power of the gas becomes very great. When the new powders came in first it was thought that a charge of one-fourth or one-third the weight of the projectile would be ample to give all the velocity that would be needed, but, owing to the desire to attain very high velocities (3,000 feet and upward), the weights of charges have been creeping up of late until now, in some guns, they approach one-half the weight of the projectile, which is the figure at which they stood roughly in the days of brown or cocoa powder.

It need hardly be pointed out here how important a matter this is as controlling the sizes of magazines of ships. Indeed, in some classes of artillery, as for instance in field artillery, where weight is of vital importance, there are many who believe that some form of nitro-glycerine powder may still be used, as it is with shoulder guns.

A word may now be said in regard to the improvements in the quality of steel in guns, and whatever is said about this may apply, it is obvious, to shafting. Ten or twelve years since or thereabouts, the tube of a large gun or a large piece of shafting which showed 40,000 pounds elastic strength was considered something rather out of the common; nowadays it is not at all unusual to be able to secure 60,000 pounds elastic strength in the same forging. This could be attained with about 16 per cent elongation. Indeed, up to guns of about 5-inch caliber, the tube and jacket of which constitute pretty reasonably sized forgings, qualities as high as 70,000 pounds elastic strength, with 16 per cent elongation, and about 130,000 ultimate strength, have been reached at Bethlehem. Nor is there any reason to anticipate that this material is any less safe to use than the softer material. Indeed, all the evidence goes the other way. It would not, perhaps, be desirable to reduce a gun's thickness of wall very materially in case this stronger material is used, but rather to consider the gained strength as so much surety against disastrous accident. Indeed it would be impossible to materially reduce the weights of guns without increasing that of their carriages, as with a lighter gun the recoil would become much more violent and harder to control. It would be very easy, if desired by ship constructors, to give the gun a larger base upon which to stand and to increase the length of recoil in many instances. As a striking example of this latter, it may be mentioned that modern quick-fire field artillery use a 3-inch gun 90 inches long, employing a recoil of 40 or 50 inches—that is, the gun recoils half of its own length. Of course it might be entirely undesirable to let a ship gun recoil through anything like such a distance as this, but there is nothing impossible about it if desired. Possibly one of the most striking changes made in gunnery in the last few years has been in the field artillery. By means of the long recoil stated, and by the adoption of the so-called spade at the end of the trail, which spade enters the ground, these guns have become capable of a very rapid rate of fire and have been fired 10 and even 20 times within a minute. The men handling them sit on seats fast to the trail, and anyone who saw the field guns of a few years since, when in action, will realize what a revolution this means.

It used to be accepted as a sort of an axiom in ship design that the armor should be so distributed and the vulnerable parts of a ship so protected that no one shot could destroy her. This has led, in view of the heavy turret guns carried by ships, to the heavy side armor, and heavy armor on the turret and barbette. I think a study of naval history will bear me out in the statement that the resistance of ships has been overcome nearly always by silencing the battery and not by destroying the ship. If this is so, a ship should carry large bored guns of respectable penetrating and mine power, and their magazines and ammunition supply arrangements should be such that they could be served at maximum rate. Roughly, if the systems of the guns are the same—that is, if the guns are of the same dimensions, when stated in calibers—then for every 12-inch gun we may have twenty-seven 4-inch guns, and as the rate of fire of each 4-inch gun, owing to the size of which the ammunition could be handled at the gun—provided it could be brought there from the magazine—is quite five times that of the 12-inch, it becomes apparent how much total metal and bursting charge is sacrificed for the heavy turret gun. Suppose a ship, instead of, say, four 12-inch guns and four 8-inch and sixteen 6-inch guns, should carry about one hundred and seventy 4-inch guns or eighty 4-inch on her broadside, or a total of fifty-six 6-inch, say. Which would be the better ship? Of course this parallel may be reasonably combated, but to me it means a great deal. If it be true that ships are overcome by their batteries being silenced—that is, by their men being driven from the guns—then the number of shots fired becomes a question of great importance.

At the present time it may be said that the principal guns of battleships are in turrets, usually in pairs, and are of 12-inch caliber. The thickness of the turret armor is 12 inches usually, or less. The so-called secondary batteries of battleships are composed of 6-inch guns, which are in broadside, and are often isolated by transverse armor and armor to their rear, which renders it unlikely that more than one of them could be silenced by the bursting of a single shell. These 6-inch guns are for the most part behind 5-inch and 6-inch armor. In other words, as the actual velocities for turret guns now afloat do not exceed an average of 2,300 feet, the turret guns of contending battleships can destroy each other only when within 600 or 700 yards range, and the guns of their secondary batteries, the ruling velocities of these being put at 2,300 or 2,400 feet, when within 1,000 yards range. More powerful guns of both classes are now being built and mounted, but a great number of 6-inch and 12-inch guns now in use would come within the approximate rule just laid down. Thus we may fix the fighting range of battleships at 1,000 yards. There appears to be no disposition to increase the caliber of the 12-inch turret guns forming the main battery of battleships, though there is considerable movement looking toward making these guns longer and heavier, and, consequently, imparting to their projectiles higher velocities than those now ruling. As respects the 6-inch guns forming the secondary batteries, naval opinion is entirely at variance. In this country there are many who would substitute for the 6-inch guns 8-inch guns, and others who would substitute 7-inch guns, while in England the bulk of opinion, so far as discoverable from published accounts, is in favor of a 7.5-inch gun, whose projectile weighs 200 pounds. To this 200-pounds projectile would be imparted a velocity of 3,000 or more feet, so that the 7.5-inch gun in England is a very large and very powerful weapon. The 7-inch gun proposed in this country and developed by our Navy Department, requires a 160-pound projectile, and to the projectile is imparted a velocity of 3,000 or more feet. There is some disposition on the continent of Europe to use lighter guns in turrets than those of 12-inch caliber, which will weigh from 45 to 50 tons; but in this country and in England the 12-inch gun seems to be pretty strongly held to. The secondary battery guns, however, as stated, are quite unsettled. Besides the 12-inch and 6-inch guns, protected, respectively, by 12-inch and 6-inch armor, battleships carry a large number of 3-inch 15-pounder guns, having a high velocity and having very little protection. The large armored cruisers, which, in their elements of offense and defense, now approach battleships very closely, carry somewhat smaller guns than the latter and their armor is accordingly reduced. When we come to the smaller vessels of all classes, the protection afforded the batteries is usually very little, besides the gun shields, and the side and other armor, of course, is also materially reduced.

There are many reasons why the battleship, armed with 12-inch guns in her turrets and 8-inch guns on her broadsides, which is the favorite battery with those who would push the weight of battery very far, would have great advantages over battleships carrying only 6-inch guns in their secondary batteries; but, if the muzzle velocities of the 8-inch guns be equal to those of the 6-inch guns, and the total weights of battery are about the same, the number of 8-inch guns would be one-half that of the 6-inch and the rate of fire of the 8-inch, as compared with the 6-inch, will be very materially reduced—it is, perhaps, not too much to say that it will be reduced by one-half. The 6-inch gun can be man-handled—that is to say, the shot can be handled by one man and all operations performed with ease, without the use of mechanical apparatus. There are many devices for simplifying the handling of projectiles and getting them into the gun, but it must always remain that the weight of the 8-inch shot—now 250 pounds—will remain a serious impediment in the way of handling the gun rapidly.

Very little has been said about the numerous small caliber guns, such as 6 and 3 and 1-pounders. These are now usually either fully automatic or semi-automatic in character, and occupy an important field in certain classes of naval warfare, such as the repulse of torpedo-boats, the protection of mine fields, and in landing operations. As regards a naval landing gun, it has been a rule to regard these in much the same way that the field gun on shore is regarded—that is, it is a question in which mobility is of great importance. Naval landing guns, however, must be materially lighter than the field gun of the army, which weighs, on its carriage and without any ammunition, about 2,000 pounds. This is obviously too heavy to be drawn over rough roads by men, and the naval landing gun, itself weighing some 500 or 600 pounds, usually weighs, with its carriage complete, about 1,200 or 1,500 pounds, and is of approximately 3-inch bore. The 6 and 3 and 1-pounders are usually conveniently disposed on the rail of a ship and in her tops, and are suited only to the attack of unprotected parts. The 1-pounders and 3-pounders are also sometimes used as landing guns.

To summarize results it may be said that, in the past ten years, by the use of better mixtures, by improved heat treatment, and by very marked improvement in face hardening, the power of armor of a fixed thickness to resist penetration has been increased about 40 per cent, while its power to resist cracking has been increased to even greater degree. This has been taken advantage of in large measure in a reduction of the thickness of armor plate on a ship's side. The total weight of armor carried is not less than formerly, and indeed it is perhaps greater than it was, but it is more spread out, and, while the protection on the vital parts is as good and perhaps better than it was, there is now some weight in armor left to cover parts that formerly were without protection.

Gun steel also—and in speaking of gun steel we may include the steel for shafting as well—has been materially improved in the period under review. The shafting steel now going into ships is very much stronger than that which was used ten years ago. It is, indeed, perhaps quite 70 or 80 per cent stronger than the former material. The advance in gun steel has not been so marked, because ten years ago the purchasers of gun steel wanted an elastic strength of about 40,000 pounds, whereas only 28,000 or 30,000 pounds was asked for in shafting. Now they both run 50,000 pounds, or even more. These very desirable and very material advances in quality have been rendered possible by the adoption of more satisfactory mixtures in the melting furnaces, and by more skillful heat treatment. They have not, however, been accomplished without much experimentation and the expenditure of a great deal of thought and money. The noted advance in the strength of gun steel has not been followed by a reduction in the thickness of gun's walls. Indeed the gun's thickness is rather greater perhaps than it was, and the increased strength serves only as an additional guarantee against disaster.

When we come to what may be called the tactical aspects of guns and armor, we find also material changes. The quality of the gun steel and of the armor, as is stated above, has advanced by perhaps 40 per cent, and full advantage has been taken of this in design. The modifications in design which have come about have been numerous. The armor is more distributed. It has come to be recognized that unprotected guns have no chance, and that 6-inch and 12-inch guns should be protected, respectively, by 6-inch and 12-inch armor. It should be noted that this means, if battleships are to penetrate each other, that ships must approach within 1,000 yards range in combat. This brings us back to the fighting range of old wooden ships, very nearly, for they had to approach within about 600 or 700 yards; and, when you consider that a battleship's 6-inch guns must have normal impact to perforate the armor protecting the 6-inch guns of their opponents at 800 or 1,000 yards, it may be said that the fighting range of ships has not so very materially altered in the past hundred years. What is here said may perhaps be combated, but, as 2,200 feet velocity in a 6-inch projectile will not, even with normal impact, carry it through 6-inch armor, nor will 2,000 feet carry a 12-inch projectile through 12-inch armor under like circumstances, it follows, when the vast preponderance of oblique impacts is considered, that ships must fight within 1,000 yards.

Finally, in closing, I want to bring forward, in order to more definitely determine the coming range of naval combat, the fact that there is one of its ruling factors which remains constant for all time. This is, the accuracy and delicacy of the firer's eyes and nerves. If a man can appreciate four intervals in a second, and if the firing apparatus put into his hands is instantaneous in action, he can hit a ship 15 feet high, at a range of about 1,000 yards, when his own gun is swinging, in rolling, at an angular rate of one degree per second. This consideration, of course, remains fixed for all time. Another important consideration is what is usually called the "danger" space. With medium calibers, with 2,000 feet velocity, the danger space is 1,100 yards. That is to say, the gun is independent of the range, as the trajectory is so nearly flat at that distance. The new guns now coming along, having 3,000 feet velocity, have a greater danger space with existing targets, and are therefore independent of the range up to 1,300 or 1,400 yards.

Whether it is better to use a 7-inch or 7.5-inch gun of the same weight as the 50-caliber 6-inch gun—that is, about 18,000 pounds, in the secondary battery of battleships, is one of the pressing questions of the day. If the 7-inch or 7.5-inch gun has its weight increased proportionately it will, of course, be better than the 6-inch, except that its rate of fire will be less from the weight of its shot, but, if we take the larger calibered gun and accept a somewhat lower velocity, while using the heavier and larger shot and

the same total weight in the gun and carriage, it may well be argued that the larger gun is the better. On the other hand, high velocity gives always an independence of the range at greater distances, and gives always greater penetration. The designer of naval ships is therefore on the horns of a dilemma with regard to the battery of the ship, as indeed he must be with regard to pretty much all her elements, and he must be guided by judgment and by a careful balancing of conditions, so that, upon the whole, and in the circumstances most likely to occur, the ship he produces will be able to give a good account of herself.

NEW PSYCHOLOGICAL APPARATUS.

CONTRIBUTIONS FROM THE PSYCHOLOGICAL LABORATORY OF THE UNIVERSITY OF CHICAGO.

By Prof. JAMES ROWLAND ANGELL and Dr. WARNER FITE.*

THE following description is offered of several pieces of apparatus, which have been found to be of practical value in the psychological laboratory of the University of Chicago.

I. A multiple contact key. This is shown in Fig. 1. It is intended to eliminate the difficulty of adjustment

FIG. 1.—MULTIPLE CONTACT KEY.

and the possible source of error found in the use of the common type of bar-key. In the keys used in the Chicago laboratory it was found that the force required to ensure double contact was liable to loosen the screws by which the adjustment for simultaneity was made, also that the bar was liable to bend slightly, giving contacts which were not exactly simultaneous. The error was occasionally found to amount to 10 σ or more. No doubt these errors can be overcome by accurate workmanship. But even granting this, the extreme accuracy and the ease of adjustment of the key herewith described lead us to regard it as preferable to the bar form of key.

The key presented here consists of a cylinder of wood (length 23.5 cm., diameter 15 cm.) mounted upon steel supports, which rest upon a wooden base. Upon the surface of the cylinder are fastened six plates of brass, 25 mm. in width, and in length equal to one-half the circumference of the sphere. The thickness is 2 mm., beveled, however, to an edge at each end. They are arranged alternately along the length of the cylinder at intervals of 12 mm. where their edges rest against a straight line drawn parallel to the axis of the cylinder. Resting firmly against the cylinder are six pairs of strips of phosphor-bronze (spring metal) which constitute the electrodes of the six electric circuits. Each strip is 2 mm. thick, 9 mm. wide, about 8 cm. high from the platform, and curved slightly at the top, so that only the edge rests against the cylinder.

FIG. 2.

The members of each pair are 6 mm. apart. Each strip is set into a circular bar of brass 25 mm. long and 9 mm. in diameter, through which there is bored a hole with a binding-screw for making connections; this bar is then continued as a screw, which passes through the projecting edge of the base and is secured to the platform by nuts above and below. This arrangement allows the strips to be raised and lowered at will. Each circuit is made when the strips rest against the brass plates of the cylinder and broken when they rest against the wood. The key thus allows three circuits to be made and three to be broken at the same moment.

* From the Psychological Review.

Simultaneity is secured by adjusting the electrodes so that the lower edge of the pair whose circuit is to be made, rests against the upper edge of the brass plate on the line where the circuits are made and broken, and so that the upper edge of the pair whose circuit is to be broken, rests against the lower edge of its corresponding brass plate on the same line. If the electrodes were filed to a sharp edge the edges might all rest upon the same line, but this was thought to be inadvisable owing to the danger of wear and the consequent disturbance of adjustment. The width of the edge renders it also necessary to confine the adjustment to one of the two lines where the brass plates end, but this is all that the use of the key requires. The simultaneous making and breaking of the several circuits is effected by turning the cylinder, in the direction of a clock, by a rapid wrist-motion, through a semi-circle; when the reaction has been made the key is turned, still in the clock-direction, back to its original position.

The key was tested on a drum, after being easily adjusted by the eye, and no error could be found. Whatever the error, it was certainly under 0.0001 of a second; and whatever error there may be in the adjustment, is minimized by the rapid motion of the surface of the cylinder, which, again, is due to its size. The only improvement we have to suggest is that, where the electrodes are passed through the platform, they be cut square instead of round, so as not to permit of rotation during adjustment. Since the accuracy of the key after adjustment depends upon the stability of form of the parts, great care must be taken, in the construction of the cylinder and the base, to secure well-seasoned wood.

II. A platform for tuning-fork and marker. This is shown in Fig. 2, attached to a Scripture drum. It is intended to facilitate the adjustment of the several forks and markers to the drum, particularly to enable them all to be withdrawn or applied in one movement. The fork and marker rest upon a steel platform (25 cm.x 7.5 cm.) down the middle line of which is cut a groove, 20 mm. wide, with projecting flanges. The fork is secured by two screwbolts, the heads of which slide in the groove, with thumbscrews on the upper end, as shown in the photograph plate. The marker is secured to a rod 10 mm. in diameter. The rod ends below in a bolthead which slides in the groove and is clamped to a platform by a thumbscrew. The fork and marker may thus be located anywhere along the length of the platform. This upper platform is screwed to a steel plate (100x80x5 mm.) which moves in a track to and from the drum upon a lower platform. The latter ends on the right in a socket which fits over an upright rod (diameter 19 mm.) and thus fixes the whole apparatus to the platform of the drum. When the fork and marker have been once adjusted to the drum, their relative position remains fixed. By means of the screw which appears at the front of the platform, they may, with the upper platform, be withdrawn from the drum and reapplied without any alteration of relative adjustment. The fork can thus be easily set in vibration before coming into contact with the drum. The head of the adjusting screw can easily be supplied with a circular vernier, if extreme delicacy and accuracy of adjustment are found necessary.

III. Thermal apparatus (Figs. 3 and 4). This consists of two parts; the first is for the purpose of maintaining a constant temperature; the second for the purpose of locating points on the skin.

a. The first appears in the lower part of the plate, resting on the larger table. The larger and smaller vessels are for hot and cold water respectively, which

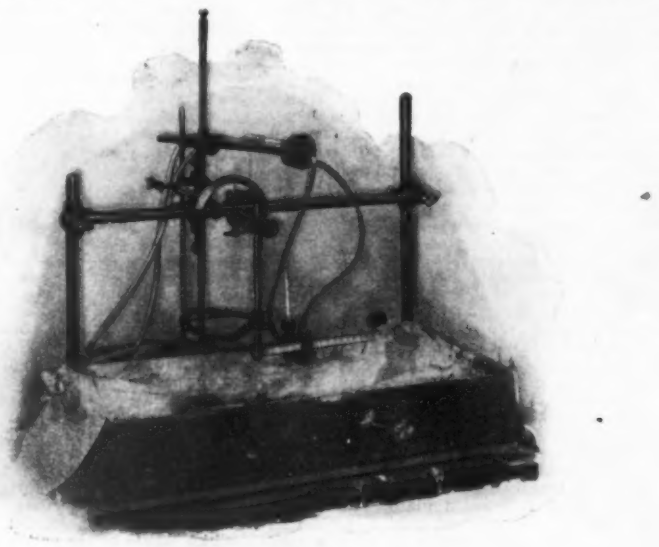


FIG. 3.

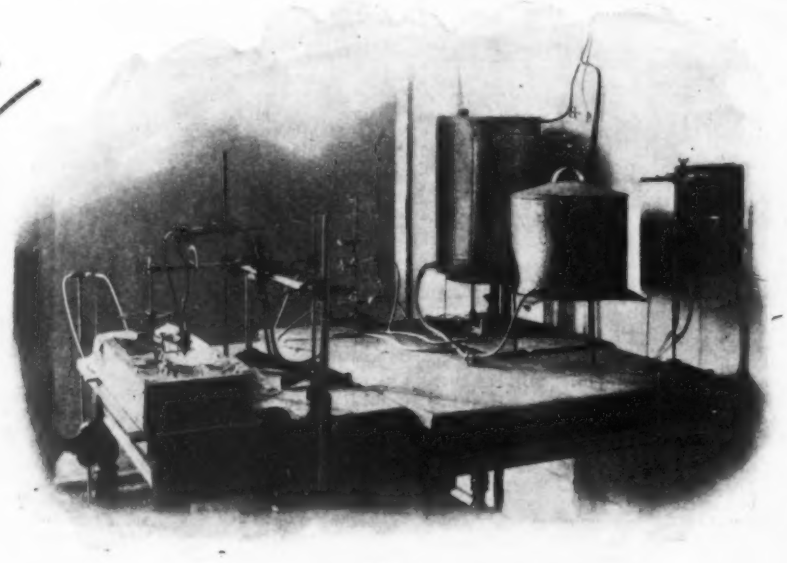


FIG. 4.

passes in a continuous stream to the temperature-point on the smaller table. The problem of keeping the hot water at a constant temperature without the aid of an assistant, is solved by employing a constant flame, a constant quantity of water and a constant supply of fresh water at an approximately constant temperature. The first can usually be secured by a group of Bunsen burners; to secure the last two we used a tank of galvanized iron (diameter 35 cm., height 50 cm.), tight at the top with the exception of a hole (diameter 4 cm.) into which as a gage we fitted a glass tube in a cork. The tank is always kept full, its fullness being indicated by the presence of water in the glass tube, which is open at the top. In order to prevent the tube from overflowing, also to avoid undue pressure within the tank, the water which comes through the feed-tube to the tank is not drawn directly from the faucet, but from a bottle with an opening near the bottom (an aspirator), which is set in a pan upon a shelf above the feed-tube, but not above the top of the tube projecting from the tank. (This part of the apparatus does not appear upon the plate.) The bottle is fed from a faucet through a tube; it is kept constantly full and the overflow is caught by the pan, from an opening at the base of which it is carried off through a rubber tube to a sink. In this manner the pressure of the water flowing through the tank is kept constant. For some purposes it is desirable to have only a small amount of water in the tank. On such occasions the pressure is of course only approximately constant. The flow of water through the apparatus as a whole is regulated by the lower glass stopcock fastened to the standard at the further end of the large table. The water flows from the temperature-point, through this stopcock, to the glass tube fixed to the standard at the rear end of the large table, thence into the funnel and out through the waste-tube to the sink. By allowing the water to fall into the funnel, instead of running out through a continuous circuit of tubing, it is possible to estimate, by the size of the

stream outlined against the black cardboard, the approximate rate of flow. The stopcock thus governs the rate of inflow as well as of outflow; if the flow outward is completely checked, the result is that all the water from the faucet overflows the aspirator into the pan and thence returns to the sink, the quantity of water in the tank remaining always the same; in this manner it is possible easily to regulate the amount of cold water coming in to cool the hot water in the tank. By adjusting the supply of gas and water any given temperature from 34 deg. C. to 60 deg. C. can be secured in the contact point and indefinitely retained. Much higher temperatures can readily be obtained, if necessary. The thermostatic devices employed to render such apparatus automatic can be applied, if desired. But the expense is thereby considerably increased.

By opening and closing the proper tubes with clamps the cold-water tank is brought into the system and the hot water separated from it. The water flowing through the cold-water tank flows not directly into the tank but through a coil of lead pipe 37 feet in length and thence out to the temperature-point. The tank itself is filled with cracked ice and salt, which cools the water during its passage through the lead-coil. Since the temperature to which the water is reduced depends upon the rate of flow, it can be regulated within certain limits by the use of the stopcock. By varying the amount of ice in the tank and, if necessary, opening the circuit from the hot-water tank, it is easily possible to secure and retain temperatures in the point ranging from +34 deg. C. to —12 deg. C. In working with temperatures below the freezing point, alcohol should be mixed with the water supplied to the coil. By substituting a small amount of ether and solid carbon dioxide for the cracked ice and salt, temperatures as low as —100 deg. C. can be obtained. The temperature at the copper point varies widely in this case with the length of tube, the wrapping, etc., between the point and tank.

Both tanks are heavily jacketed with asbestos, which is not shown in the plate. The cut fails also to show a stopcock for drawing off the melted ice from the cold-water tank. Double tubing is used to connect the point with the cold-water tank. This has not been found necessary with the hot-water system. In work with the extreme temperatures we cover all but the tip of the copper contact point with felt. This practically eliminates disturbing radial effects from the lateral surface of the cone. Thermally opaque screens with apertures of any desired size can of course be used, where a more complete elimination of this factor is desired.

b. The upper part of the plate shows in detail the temperature-point and its adjustments.* The point consists of a pyramidal vessel of thin copper, 35 mm. in height, 35 mm. in width across the top. Soldered to the top on opposite sides are two tubes (internal diameter 2 mm.); one of these extends through the top to the lower point of the vessel, which ensures the passage to that point of all the water entering the vessel. Into an opening in the top of the vessel is fixed a rubber cork, holding a thermometer, the bulb of which extends to the bottom of the vessel. For this purpose special thermometers were constructed with the particular ranges of temperature desired. The gradations show a degree to the ¼ inch. The temperature-point is fixed to the clamp which slides on the graduated rod, but is extended from it 5 cm. by means of two thin strips of spring brass, which insure the return of the point to its original position after being pressed against the skin. The position of the point may be varied in four ways: by rotation in a vertical plane, measured on the upper of the two circular scales; by rotation in a horizontal plane, measured on the lower circular scale; by a vertical movement of the rod holding the lower scale regulated by the rack-and-pinion movement at the top of the rod which acts also as a vernier; and by sliding the clamp along the lower horizontal rod. The arm upon which, in the arrangement shown by the cut, it is proposed to locate the temperature-spots, is held in a plaster cast in the large box beneath the temperature-point. The whole apparatus is clamped firmly to the table, so that, by noting the registration on the several scales, it is possible to adjust the apparatus for any desired point. If the arm remains absolutely fixed this means an absolute location of any point on the arm.

So far as we are aware this apparatus can be employed in connection with any of the supplementary devices for securing accuracy in the localization and identification of points on the skin. It pretends to no special novelty, being merely a combination of arrangements already familiar in apparatus designed for these purposes. But it has proved very convenient and it is quite inexpensive, when compared with the more elaborate instruments, such as the kinesimeter of Hall and Donaldson.

* This is similar in many ways to that described by Miss Washburn in the American Journal of Psychology, vi., 423.

THE NEW GEYSER IN NEW ZEALAND.

IN the central part of North Island, New Zealand, just south of the Auckland Peninsula, lies a region which is remarkable for violent volcanic action. It extends from the Ruapeho Mountains across Lake Taupo to the Bay of Plenty, and is known as the "Hot Lake District." On account of the great number of thermal phenomena, the incomparable scenery, and the mild climate, as well as the pleasure offered the tourist of learning the manners and customs of the natives of various races, this district is the most interesting part of the Maori country, so rich in natural wonders. Only a few years ago the region was almost inaccessible, but now it can be reached by railroad from Auckland in a day, and is therefore visited by many tourists, and hundreds of invalids are also attracted by the world-renowned medicinal springs. The district covers about 400 square miles, the surface of which is often changed by volcanic eruptions, as in June, 1886, when the celebrated calc-sinter deposit known as the Pink and White Terraces of Rotomahana disappeared forever, and more recently when the Waimangu Geyser (shown in the accompanying engraving) was formed.

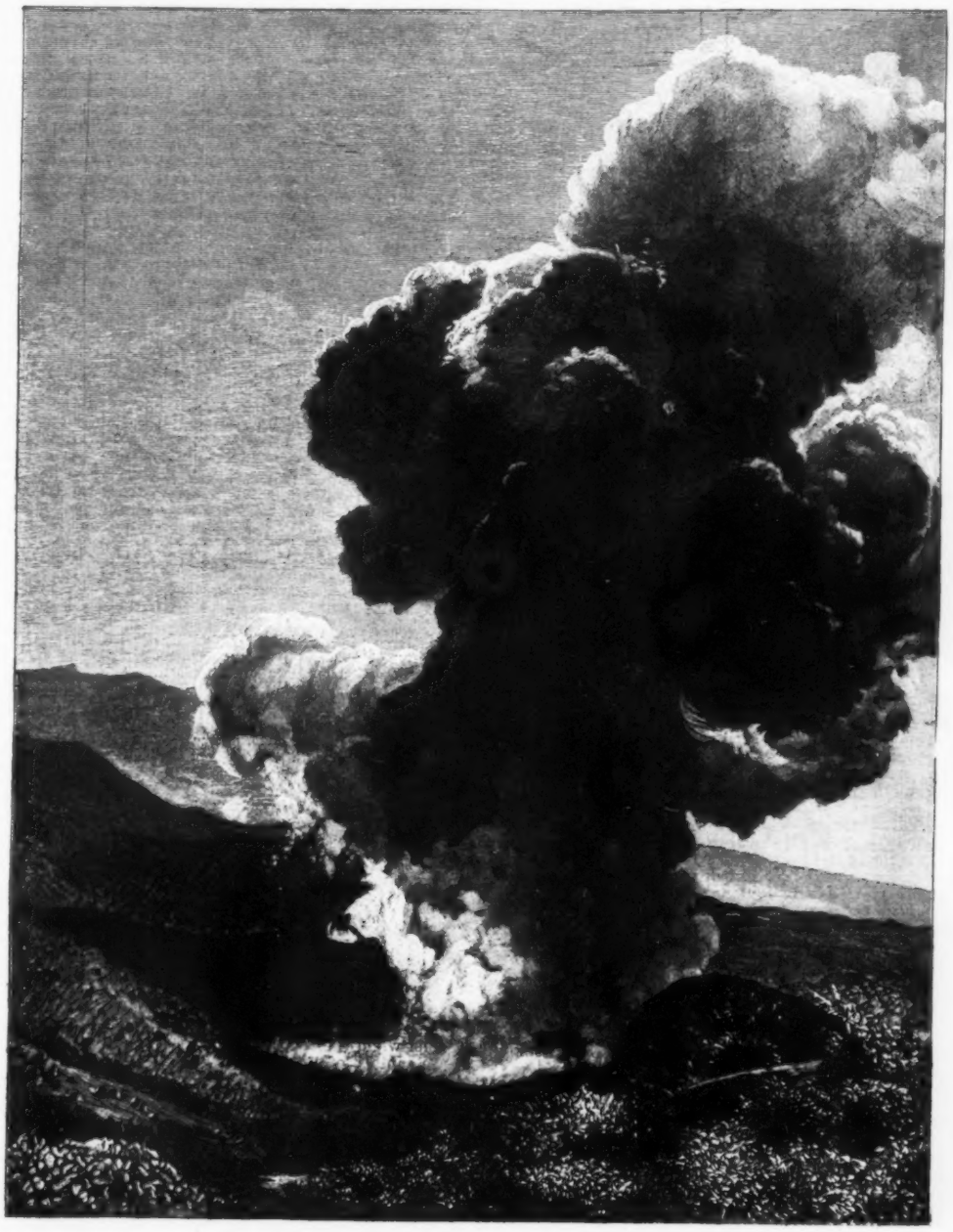
In the valley of Echo Mountain the ground was formerly pierced by innumerable apertures of different sizes, from which streams of hot water and jets of steam issued at intervals. Now the landscape presents an entirely different aspect, for all of these little geysers have vanished to make way for a giant of their own kind which far surpasses in height and power all former New Zealand geysers. This valley is so difficult of access that it is seldom visited by human beings, and therefore it was some time before this change in the scenery was known. It was first discovered by Dr. Humphry Haines, who, when taking a trip to the southern end of the great Rotomahana Crevice, passed through the Waimangu Valley, with which he had become familiar during a former visit to that region.

Travelers who wish to visit the new geysers will leave the railroad at Rotura, the terminus of the road and the center of the Hot Lake District, and located on the shore of charming Lake Rotura, a modern watering place with a sanatorium supported by the government and several hotels fitted with every comfort. From here the journey to Parnheru must be made on horseback. After crossing the hills near this place, a little cloud of steam is seen to rise beyond Inferno Mountain, which seems to increase gradually as it is approached, but the great changes caused by the last eruption are not realized until after the tourist has passed Southern Mountain. Between Echo Mountain and Boiling River a small round lake has been formed, from the center of which, at intervals of varying lengths, a thick column of black, seething and foaming water is hurled high in the air, carrying with it mud and stones. This column maintains a uniform thickness to a height of 650 to 800 feet, where it seems to remain stationary for a moment and then it breaks, and the falling masses of black water unite with the snowy clouds of surging and hissing steam that rise majestically from the lake to a great height, being finally lost in the blue of the sky.

When active the geyser is a most imposing sight, but it is not safe to approach too near the shore of the lake, for the stones and mud which have been carried up by the water are thrown over the neighboring hills and valleys for a distance of 1,600 to 1,900 feet. The great quantities of material that have been cast out of the lake would indicate that it must be very deep, but it has, of course, never been sounded, for even when the geyser is inactive clouds of steam are continuously rising from the turbid water.

But it is not only in the immediate neighborhood of this lake that great changes are noticeable, for we find that Inferno Cascade has disappeared and its beautiful white sinter basin is covered with mud; and the upper part of the Boiling River, where vegetation had begun to throw out roots among the rocks and where there were innumerable little geysers, has also gone. Everything here is covered with mud and stones thrown out by the new geyser, so that this valley, once so charming, looks like a monotonous gray desert.

A path is to be laid out between Parnheru and the new geyser, so that the latter will be reached with much less difficulty. Our illustration shows a view of the geyser, taken just at the moment when the column of water has attained its greatest height.—For this and the above data we are indebted to the Illustrirte Zeitung.



THE NEW GEYSER IN NEW ZEALAND.

THE MEDITERRANEAN TUNNY.

THE Mediterranean tunny is a classic and important fish. Like many other important fish, however, his habits and his life history are but little known. In this he much resembles the salmon, though the great attention which has of late years been bestowed upon the salmon has in its case given us a store of information which is at present lacking in the case of the tunny. The tunny is, at any rate, a fish of noble proportions. The most valuable of the mackerel tribe, to which the bonito and the albacore also belong, he frequently attains the weight of 1,000 pounds, many of this weight being caught in the fixed nets off the Ægadian Islands; while Cetti, the natural historian of Sardinia, mentions a specimen caught on that coast which weighed 1,800 pounds, and I saw one captured this year which weighed 500 pounds less. In Sardinia they classify the tunny according to weight; a tunny of less than 100 pounds is a scampirre, a tunny from 100 pounds to 300 pounds is a mezzotunno, and a tunno properly so called is a fish that weighs over 300 pounds.

The natural history of the tunny has from the earliest times been a subject of much dispute. Aristotle, in his History of Animals, devotes some space to it, and seems to have been the earliest writer to attempt any scientific description of it. In his day the tunny was so plentiful in the Black Sea that he was of opinion that it was their one great breeding ground, though he was well aware that they made their appearance in large numbers at many places along the coasts of the Mediterranean; and he mentions one specimen which measured "two forearms and a palm" across the fork of the tail, and weighed fifteen talents, or some 1,200 pounds. He has, however, failed to convince naturalists who have inquired into the matter since when he labored to distinguish the male

from the female by giving the latter an extra fin. Nor, indeed, has his assertion that the Black Sea was the one breeding-ground of the tunny been received with much greater acquiescence; there is still much controversy as to where the tunny breeds, and where he comes from. One school of naturalists maintains that he is really an Atlantic fish, whose home is in the north, and that he migrates annually from the ocean waters down through the Straits of Gibraltar, when the spring comes round, to breed in the shallow gulfs of the Mediterranean, and that he returns to the Atlantic some months later. There seems to be a good deal to support this view, from the fact that tunnies are seen and caught off the coasts of Scotland and Ireland, sometimes playing sad havoc with herring nets, and they regularly appear in the Mediterranean in the spring, apparently traveling east; while in the autumn they are captured traveling west after having spawned, and, according to this theory, they would then be seeking to return to the ocean to which they properly belonged. Not all, however, during this southern migration pass through the Straits of Gibraltar; they would appear to divide at this point, as they are found in large numbers off the western coast of Northern Africa simultaneously with their annual spring advent in the Mediterranean. Cuvier, however, who is the most distinguished supporter of the other school, contends that, though certain numbers of the fish may migrate annually from the Atlantic, the greater part of those caught in the Mediterranean can never have come from the Atlantic at all, and that their real home is in the deep waters of the great inland sea. These, like the migrating shoals from the Atlantic, seek shallow and warm water during the breeding season, and when that is over retire to the deeper parts of the sea. The question in 1830 became one not merely of natural history but of practical politics, when the question of fixed versus drag nets became a burning one. The opponents of the privileged owners of the fixed net fisheries contended that, as the fish was a migratory one, and regularly traveled over certain well-defined lines of route in their passage from and to the Atlantic, the owners of the fixed nets were taking more than a fair share from the migrating shoals, and were destroying the industry—a complaint which is not unheard of at the present time with regard to salmon nets. It was, however, denied that there was any proof that the migration of the tunny was confined within any such defined limits, or that any injustice was done to the ordinary fishermen by the setting of fixed nets at particular points, which accordingly remained. The range of the tunny is a very wide one; Dr. Günther, a high authority on the subject, distributes him from the south coasts of England to the shores of Tasmania. His food consists of herring and pilchard and other small fish, on which he thrives and grows with amazing rapidity. Cuvier records that at his first appearance on the Mediterranean coasts after the hatching season his weight is two ounces, which he doubles in a fortnight, and at two months old he weighs two pounds, and continues to put on weight with a corresponding rapidity, till in some instances he reaches the great size of 1,800 pounds recorded by Cetti.

The industry of catching tunnies is a very ancient as well as lucrative one. Allusions to it run through the classics. Two hundred and twenty-eight years before the Christian era Athenæus took the trouble to prove that a brother scribe had made a mistake in attributing a panegyric of the tunny to Hesiod, and modern scholars have agreed that the first authentic classic reference to the tunny is by Herodotus. That the capture of the tunny was a familiar feature in the daily life of these times is proved by the story related by Herodotus, who tells us how Pisistratus, returning to Greece after his second expulsion, pitched his camp opposite to that of his adversaries near the temple of Pallas at Pallene. Here a soothsayer, Amphilytus by name, moved by a divine impulse, approached him and uttered this prophecy:

> Now the cast has been made, the net is outspread in the water,
> Through the moonshiny night, the tunnies will enter the meshes.
> Herodotus, i. 62 (Rawlinson's translation).

Pisistratus grasped the meaning at once, accepted the oracle, fell upon the Athenians, defeated them, and returned to power. Æschylus, also in the Persæ, makes the messenger describing the battle of Salamis say:

> And they, as men spear tunnies, or a haul
> Of other fishes, with the shaft of oars
> Or spars of wrecks went smiting, cleaving down.
> Persæ, 424 (Plumptre).

Small mercy was apparently shown the tunny in ancient as in modern times. Aristophanes, in the Wasps, employs or coins the word θυννάζειν "to tunny," in the sense of striking with a spear; and the ancients, besides ill-treating the tunny, were the reverse of complimentary to his intelligence, as with them the θυννοειδής was the stupid or tunny-faced man, the Greek equivalent to our own "chub-faced fool" of Elizabethan times, which would show that the tunny was as well known in the Mediterranean as the chub in the Avon. But, indeed, the tunny has been the theme of historians, of poets, and of naturalists, almost since history in Europe began; and from Herodotus downward the ancients have sung his praises, dedicated him to their deities, stamped his effigy on their medals, and used the methods of his capture to point their illustrations.

The chief tunny fisheries of the ancients were carried on at the eastern and western extremities of the Mediterranean, and in narrow waters, where migrating fish were obliged to concentrate. The Black Sea was certainly a favorite breeding-ground, perhaps, as Cuvier opines, because of the great rivers which flow into it. Pliny confirms Aristotle in this particular, and mentions the huge shoals of tunnies which made their appearance in the early summer in these waters. But there is much historical allusion to other great fisheries in the western portions of the Mediterranean and even in the Atlantic. The Phœnicians certainly established tunny fisheries both on the Atlantic and Mediterranean coasts of Spain, and have left effigies of the fish on their medals of Cadiz and Carteia. Ælianus writes of the fisheries carried on by the Gauls at Marseilles, where the tunny was caught "with great hooks of steel"—that is, gaffed and dragged on shore when netted, as he is at the present day. The Sardinian fisheries were especially celebrated in Roman times; the Roman epicures, indeed, esteemed the Sardinian fish above those of the Bosphorus, and Salsamentum Sardinicum was the Roman name for the preserved article. The Spanish salted tunny was also famous, and connoisseurs professed to detect in it a peculiar nutty flavor, which, they held, was derived from the acorns of the small oak which in those days overhung the coasts of the Peninsula. Famous fisheries also existed then, as well as now, on the shores of Sicily.

It was the fishery of the Bosphorus, however, which attracted the most notice, both in classical and mediæval times, and its importance is measured by the number and detailed character of the descriptive passages. They are carefully collated in Cuvier's great work published in 1831; and from its testimony to the abundance of the tunny in the Bosphorus as well as its account of the origin of the term of the Golden Horn, the following passage seems worthy of quotation:

"Mais c'était surtout la ville de Byzance que le poisson enrichissait," says the Baron. "Les thons arrivés aux isles Cyaniés entraient dans le Bosphore, et près de Calcédoine ils rencontraient une roche blanche qui les effrayait, et les forçait de se détourner du côte de Byzance et d'entrer dans ce golfe qui est aujourd'hui le port de Constantinople, et que les Calcédoniens en profitaient fort peu. C'était à cause de cette abondance de thons que le golfe en question avait pris le nom de Corne Dorée, et Apolonius avait appelé Calcédoine 'la ville des aveugles,' parce que ses fondateurs n'avaient pas su reconnaître cette infériorité du lieu qu'ils avaient choisi."

In later times the Black Sea seems to have lost its distinction as the favorite haunt of the tunny, while the industry has developed in the more central waters of the Mediterranean. The western fisheries held out longer. The Atlantic fisheries of tunny were important industries till the middle of the eighteenth century. The Dukes of Medina Sidonia owned the most famous ones, and drew a large part of their revenues from them; they were situated at Cerril, near Cadiz, and at the Château of Sara, near Cape Spartel, and at the time found employment for five hundred men. But they gradually fell into mismanagement and decay, and by the middle of the century had declined into quite unimportant industries. One reads but little of them after 1755, except a kind of obituary notice, which declares that the earthquake of that year, which converted Lisbon into a heap of ruins, so altered the configuration of the Spanish coasts that the tunnies which had frequented them sought elsewhere for more congenial breeding-grounds. Thenceforward the coasts of Catalonia, Provence, Liguria, Sardinia, and, above all, Sicily, became the more important centers of the industry.

A fish so historic, so valuable, and of such goodly proportions may well be worth the angler's attention; a finny prize of 1,000 pounds or even 500 pounds is not to be despised, and if the tunny can be caught in the Mediterranean, why journey to the far-off Pacific? There, indeed, at Santa Catalina, on the Pacific Coast, tunnies, or, as they are there called, the flying tuna, are caught with rod and line every year in May and June. The bait used is a flying-fish, in pursuit of which the tunnies appear every spring in large numbers, churning the sea into foam, and leaping in pursuit of their flying quarry; whence the name of the "flying tuna." The tackle used is similar to that employed for the capture of the tarpon, the king of the herring, as the tunny is the king of the mackerel tribe. The fish make their appearance in May, and the angling continues till August, the best of it beginning about the 15th of June and lasting for a month. Judging from those that are caught with the rod, the Pacific tuna does not seem to attain to anything like the same proportions as the tunny of the deep-sea waters of the central Mediterranean. Some 250 pounds weight is the record of the Tuna Club, which has the strictest rules and regulations with regard to membership. The rod used by a would-be member to kill his fish must not be of more than a certain length or weight, nor the line of more than a certain thickness, and the aspirant, if he would qualify for membership, must wield the rod the whole time with his own hands; the captain of the club for the year being the member who catches the largest tuna of the year under these conditions. The fish are very exhausting to play, sometimes taking as much as six hours, or even more; but a little practice with the rod wonderfully shortens the time required to kill the fish, when muscles have got accustomed to bear the strain, and skill has come with experience. At first it seems absurd to attempt to land anything of the size, strength, and activity of the tuna with a frail rod and line, but nevertheless it can be done. The fish, as a matter of fact, tires himself out if he be not allowed to get his second wind, and the greatest possible strain is kept on him without relaxation all the time. It is almost incredible what monsters of the deep can be landed with the rod and line; black bass and Jew fish of preposterous dimensions can, with strength, time, and skill be gradually worked up from the depths of the ocean; 700 pounds weight of struggling fish-life has been successfully brought to the gaff in the shape of Mr. Vom Hofe's swordfish, and a swordfish is no mean fighter, besides being a lightning swimmer; and I, myself, when in Florida in 1899, had an experience that the rod and reel were mightier than the chain and rope. Boca Grande Pass was swarming with sharks, a large number no doubt always living there, and a large number being collected by the tarpon fishing. Every night from the little yacht on which we lived we used to put out shark tackle with hooks and chains of portentous size and thickness, and every night the sharks used to break them and carry them off till they were all gone. Nevertheless, at the close of my stay at Boca Grande, with a rod and line I caught a shark which was bigger than any I saw besides. He took a tarpon I was playing, an average-sized fish in a year in which the fish ran large, of some 120 pounds, and whether he swallowed the whole fish or only the head portion of it I do not know, but certainly he got well hooked, and after a violent engagement, which lasted about forty minutes, he was gaffed and lay still by the side of the boat, than which he was to all appearance very much longer—so much so that all idea of pulling him into it was given up, and, the yacht being some four miles off, it was not considered worth while dragging him there, so after a few pats on the head he was let go. This episode is only alluded to as an instance of the size of fish which can be captured with a rod; and if these things can be done in the Atlantic and in the Pacific, why should they not be feasible in the Mediterranean?

That is a problem which I and a companion set out to solve this spring with a proper equipment of rods, hooks, and lines. From all accounts, the tunnies off the Ægadian Islands on the west coast of Sicily, Formice, Levanzo, Favignana, and Maritimo, were those most worthy of attention, running, as they were reputed to, and indeed did, up to 1,200 pounds, and not the lesser fry of the North African and other coasts of the Mediterranean, small fish from 150 to 300 pounds. So to Trapani we went, the chief town on the mainland, within easy hail of the islands aforesaid and the tunnies which they sheltered. And Trapani would make an ideal fishing headquarters, easy of access either by Marseilles and Tunis, the way we went, which, with a brief call at Tunis, obviates any change of boat, or by Naples and Palermo, the route by which we came back. Close to the harbor there was a fine hotel, with the inevitable statue of Garibaldi in front of it, and the haunts of the tunny can be reached within a very short time from it. Here, if they would but take like gudgeon in the Henley Reach, you could catch tunnies as big as you would fancy on the famous Regatta course of old, where the pious Æneas celebrated his father's memory by the institution of a Grand Challenge race strictly confined to home talent. The very rock on which Æneas set up the oak to mark the turning-point in the race, in rounding which Gyas hurled his coxswain into the sea for what he considered bad steering, is a well-known spot in the tunny fishery of to-day, which is carried on over the course where Mnestheus, Sergestes, and the impatient Gyas urged their respective crews, and indirectly engraved the motto "Possunt quia posse videntur" on the medals which now commemorate a victory in the Oxford and Cambridge University boat race. That the fish were there we soon had ocular demonstration, for, steaming out in our little launch to the fixed tunny-nets off the island of Formice, we were allowed by the Reis or head man at the fishery to row over one of the net chambers in which the fish were confined, and to look down upon some hundreds of them quietly swimming about below unconscious of the doom that was awaiting them in the Camera del Morte, a few chambers off. But besides allowing us to see the fish, for which we were grateful, the Reis imparted to us a piece of information which considerably damped our piscatorial ardor—namely, that at that time of year the tunnies ate nothing at all; they are in love, said the Reis, and they eat nothing. They wander round in large shoals and enter the nets and are quite happy, their motto for the time being "the more the merrier"; in fact, frequently in the night the tunnies inside the nets were joined by tunnies from outside, which forced their way through the unsubstantial network of the outer chambers, and, when once there, remained contentedly without employing a similar method of exit to regain their freedom in the open sea. Further investigations from young and old inhabitants served, alas, only to confirm this theory, which was strengthened by the fact that when the thousands of tunny which are caught at this time of year along the Sicilian coasts were opened, no traces of food were found inside them. Later on they would take; after the feast of St. Peter, men caught them trailing behind the sailing boats, and desperate fights they had with them, ending in the local hospital—but with good thick ropes and three men to pull, not with wretched little lines and reels such as we had, which no self-respecting tunny would take the smallest notice of. This information appeared to be as accurate as it was disappointing, and in other surroundings would have been distressing;' but at Trapani, as indeed elsewhere in Sicily, there is so much that is curious, interesting, and indeed exciting, that a week spent there is not ill spent, even though the tunnies in May will not take a bait. The bay, shaped like a sickle, which gave its name to Trapani, the ancient Drepanum and the celebrated Temple of Venus Ericyna on the summit of Monte San Giuliano, has seen many strange sights and a long procession of fresh conquerors and changing civilizations since the first great regatta. Trojans, Athenians, Syracusans, Carthaginians, Romans, Vandals, Saracens, Normans, French, Spaniards, and Austrians have all fought around them, and many have left their mark, which lasts to the present day. The town of Trapani itself remains very Spanish in appearance, while in almost every street are found feudal mansions with heavy portals which date from the time of the Norman or Aragonese occupation; but far more interesting than the buildings and the relics of peoples who have passed away is the social condition which prevails over a large portion of Sicily at the present time, the continual and apparently ineffectual struggle of the law against a system of terrorism which is apparently stronger than the law. I had not been two hours in Sicily after landing at Palermo before I was introduced to the Mafia. There were no less than fifty-two of them in an iron cage being tried for various crimes, which included most known ones, and culminated with one connected with four bodies which were found hidden in a well. The accused, some of whom presented the appearance of fairly respectable shopkeepers, had been rounded up at various times as being implicated in a long series of offenses against the law, and the trial, which had already lasted a fortnight, was expected to go on for some time longer. The court was filled with sympathizers, and the iron bars which formed the ceiling as well as the sides of the dock were there to make impossible those wild dashes for liberty which prisoners on their trial had made before now, when the authorities of the law had not received much assistance from the other occupants of the court. The fact is that the Mafia are so strong in the country that they receive direct or indirect support from the highest in the land, and none are so powerful but it is worth their while to be on good terms with them; even the

a rich man who can boast of almost belonging to the craft and who subsidizes them regularly every year, cannot let his son walk in his own garden without an armed guard. Strangers are safe from molestation, but there are very few rich people in Palermo who would take an unprotected walk in the hills in the neighborhood; while most men habitually carry what in Western America is called a gun. In the infested districts the Mafia take their toll of everything; and it is a remarkable fact, and some indication of the insecurity of the inner portion of the island, that Sicily, which in Roman times was the granary of the republic, is now a large importer of corn and flour. The system, however, notwithstanding the efforts made against it in times past by the Bourbons and the police and convict establishments which meet one at every turn, seems ingrained in the habits of the people as a kind of baneful freemasonry, and its profession is so lucrative to those that profit by it that it will be a hard matter indeed to stamp it out.

Before leaving Sicily, however, we saw a dire revenge taken on the tunnies which had despised our allurements. At Favignana, where a slab attached to a door of a church in the island records a famous catch which took place more than four hundred years ago, there is still the most lucrative tunny fishery in Sicily, and through the kindness of its proprietor, Commendatore Florio, to whom most things in Sicily belong, we were the privileged spectators of more than one "matanza," and a "matanza" is a sight well worth seeing. The fish are guided into the chambers, which open one into the other till they end in the chamber of death, by long arms of coarse netting, which stretch out on either side to intercept the shoals which pursue a regular course, and cause them to coast round till they find the opening into the chamber, which they unsuspectingly enter. These arms are sometimes some four miles in length, one being known as the "coda" or tail, and the other as the "costa," and they both end in the "campile." The tunny is a gentle and curious fish, and is apparently not alarmed at finding himself in confinement, and never seems to make a dash through the nets, which at this stage he could do without much difficulty, but only follows them round till he finds his passage unimpeded. The nets are kept in position by a hawser at the top called a "sommo," which is kept afloat by large pieces of cork, and a hawser at the bottom called the "piombo," which is weighted with large pieces of stone; the vertical lines which connect the two are called "modellari," and the whole is made secure by anchors placed at stated intervals. Men in barges are constantly on the watch over the nets, and by long practice can state with absolute precision the number of fish that have entered the chambers. They can be passed from one chamber to another by opening the door, which is done by letting the net over the aperture drop, and closing it again by pulling it up after they have gone through. If the fish are unwilling to move as required, advantage is taken of their curiosity, and something bright exhibited at the opening, and when one has passed through to see what it is, all the rest follow. So they are moved on, and when there is a sufficient number collected in the penultimate chamber preparations are made for the "matanza." The last chamber is the chamber of death, and no tunny once across its fatal threshold comes out alive. It is formed of much stronger netting than the other compartments, each of which also has its separate name, and its bottom, too, is made of netting attached by thick hawsers to large bundles of cork known as "cagnazzi." When the day of the "matanza" arrives, the fish being secured in the "camera del morte," three sides of it are inclosed by huge barges, while another huge barge crammed with men, beginning at the distant end of the compartment, slowly approaches them broadside on, dragged forward by means of the bottom net, which is thus brought to the surface and dropped as the barge passes on. In the middle during the whole time there is the head-man in a boat directing the raising of the net beneath him. The whole operation is carried on to the accompaniment of weird cries from the multitude of men who are hauling up the net. For some time there is nothing to be seen, but as the moving barge approaches there is suddenly the great swirl caused by the first rush of the empty fish to the surface, which is by far the finest sight in the day's work. Soon after this, as the fatal net rises, the whole of the water is one sheet of foam and spray flung high over the barges, which inclose it on all sides. Here and there a swordfish is seen darting this way and that in the extremity of terror, and the great forked tails of the tunnies lash the water in their futile struggles to escape. But soon the spray, which was as white as snow, gets tinged with red, and finally becomes more red than white, as the iron hooks attached to short poles are driven into the sides of the unfortunate fish, which with incredible rapidity and scant ceremony are dragged up over the gunwale of the barge, and fall into its capacious hold with a resounding thud. Each man is a trained hand, very often with inherited ability, and occupies his allotted post, and in a very short time the two end barges begin to sink in the water with a load of some seven hundred tunnies averaging more than 500 pounds apiece. Meanwhile, as each fish is tumbled in, an old man with a long spear thrusts at them just behind the pectoral fin to make the blood flow, and the great tails thumping the bottom boards scatter it in jets. It is not a very pleasant sight, the last scenes of a "matanza," and it is not sport—it is merely catching tunnies, and the tunny is a valuable fish. When the last of the catch has been hauled in and none escape, a short chant is sung to the Blessed Virgin, and the long line of laden barges sets out toward the shore, where a hard day's work awaits the men employed. The destination is a huge factory filled with every possible appliance for dealing with the catch, however great. Here the fish are dragged up an inclined plane, laid in lines, and their heads cut off by a headsman with a long axe, who performs the operation in two strokes, the intestines are removed, and the roe and milt carried off in wooded troughs and placed in brine. The fish is then hung up by the tail for about eight hours, after which he is cut up and boiled in copper vats, and then the pieces are carefully placed in tins, fitted in like a child's puzzle, the tins are filled with oil and soldered down. Every part of the tunny is used and has its particular name. There are four different qualities preserved in oil, "tarantello" and "sorra," the fattest part of the breast; "tonno," the back and tail end; and "molliche," small parts of all qualities mixed together. The "spinella bianca" (loins), "codacchio" (tail), "busenaglia" (black flesh), and "occhi" (eyes) are each salted separately in barrels. The heads are boiled for oil, and the bones and ashes are sold as manure, a use being thus found for every portion of the unfortunate creature's anatomy. A good tunny fishery is a valuable possession, the heavy fish of Favignana being worth on an average some £4 net, and ten to twelve thousand in the season is by no means an unprecedented catch. The largest individual catch this year weighed 1,300 pounds. One of the most striking features is the great number of men employed at the factory, and the discipline and rapidity with which they work. There was at Favignana the usual convict establishment, and the convicts are employed in the packing of the pieces of tunny into the tins, which are also all made on the spot. Italy, and especially Genoa, is the great customer for the finished article, which is protected by high duties from the competition of the Sardinian and Spanish fisheries.

The tunnies are certainly there in large numbers and of great size; perhaps when they are no longer in love, and the feast of St. Peter is safely past, those that have escaped the dread portals of the "camera del morte" might be induced to take a bait, even as they do in the Pacific, and then, indeed, a Homeric struggle would ensue. A 500-pound tunny would undoubtedly take some catching on a rod: he is from all accounts a strong though timid fish, and goes straight away from you in desperate long runs. In this he differs from the tarpon, with a hundred of whom I have made intimate acquaintance within the space of three weeks; a most impetuous fish, who will rush anywhere when he is hooked, and even fling himself into your own boat, as I have seen happen on more than one occasion. But this prize of the Ægadian Islands will not be brought to the gaff without the help of those tutelary deities of the sea who have before now helped sportsmen in difficulties on this historic spot in the brave days of old.—W. H. Grenfell, in The Nineteenth Century. By permission Leonard Scott Publication Company.

EDUCATIONAL REFORMS IN CHINA.

MINISTER CONGER transmits from Pekin, October 1, 1901, translations of two imperial edicts providing for the establishing of schools throughout the Empire, and ordering the viceroys and governors to select and send students abroad for the purpose of being educated in special branches of industrial science. The edicts follow:

[Translation from the Pekin Gazette of September 29, 1901.]

On the 5th day of the eighth moon, the following imperial edict was received:

The development of men's talents is certainly at the present time of urgent importance. Some time since it was proposed by the provincial authorities of Kiangnan, Hupeh, and Szechuen to select and send students abroad to travel and study—an excellent suggestion.

Let the viceroys and governors of the various provinces all act in accordance with it and exert themselves to select students of mental gifts, upright character, literary talents, and a general knowledge of affairs, who shall go abroad to thoroughly educate themselves, particularly in the specialized branches of industrial science. Let them acquire a thorough mastery of some profession, and genuinely exert themselves in the pursuit of knowledge.

When their education shall have been completed and they shall have obtained their diplomas and returned to China, let the viceroys and governors and literary chancellors of the provinces concerned at once divide them into classes, according to the courses of study which they may have pursued, and examine them. If their knowledge shall really correspond with the statements made in their diplomas, the authorities mentioned shall issue a document certifying the same, and send it with the student to the Board of Foreign Affairs, who, after further examination, shall select the most worthy and memorialize us, requesting honors to be conferred on them. As to the expenses attendant upon such travel and study, let each province arrange some satisfactory method of paying the same, and it will be permitted to enter the item under the head of government expenditure.

Should any person go abroad to study at his own expense, let the viceroy and governor of his province at once report the fact to the Chinese minister in the country to be visited, that he may look after such students as occasion may require. If he shall complete his course of study and obtain a first-class diploma, on his return to China he shall be permitted to enter the examinations on the same terms as the students who have been sent abroad by the government. Afterward, they will await an imperial decree bestowing upon them, according to their attainments, the degrees of doctor and master of arts, that they may be prepared for official employment and to encourage the pursuit of learning.

Let this edict be published abroad for general information. Respect this.

[Translation from the Universal Gazette, Shanghai, China, September 17, 1901.]

On the 4th day of the eighth moon a telegram was received saying that on the 1st day of the same moon (September 13, 1901) the following imperial edict was issued:

Human talent lies at the foundation of all affairs, and in the cultivation of talent the most important thing is the improvement of educational methods. From of old it has been the glory of the academy that it has laid emphasis upon the practice of virtue and the cultivation of the arts. Therefore, in such times both theory and practice were attended to, and men of talent and virtue were numerous. But nowadays scholars are either empty pretenders or of no use or are fickle and wanting in sincerity. At present it is desired to remove these evils; but without reverence for teaching and exhortation to study there is no way of prospering the undertaking.

Aside from the Imperial University at Pekin, which must be put in thorough order, it is commanded the viceroys and governors of the various provinces, each to convert the schools at the provincial capital into a college, and let each prefecture, subprefecture, and independent department establish an intermediate school, and each department and district a lower grade school with numerous primary schools. In the curriculum let the four books and five classics, with the three bonds and five virtues, form in a general way the foundation, and history, Chinese and foreign government, and industrial science to be employed to supplement this course. Let earnest effort be made to inform the mind, to secure upright conduct, to improve both literary talents and character, and produce men acquainted with the times, diligent in the pursuit of real usefulness. This will approximate the laying of a foundation (for) the completion of virtue and the improvement of talent, which will assist in fulfilling the purpose of the Throne to secure men equipped for the duties of government. Let each of the viceroys, governors, and literary chancellors earnestly consult together and proceed as directed. As to the teachers needed, the rules to be established for the schools, and the methods to be employed to reward those students who shall complete the course of instruction, and all the details of such regulations, let the board of national administration issue instructions to all the provincial authorities to prepare the same, and when they shall have been submitted, let the said board, together with the board of rites, again examine them and prepare a memorial.

Let this edict be published abroad for general information. Respect this.

PHYSIOLOGICAL ACTION OF RADIUM RAYS.*

THE rays of radium act energetically on the skin. The effect produced is similar to that resulting from the action of the Röntgen rays.

The first observation of this action was by Messrs. Walkoff and Giesel. Mr. Giesel kept on his hands, for two hours, radiferous barium bromide enveloped in a sheath of celluloid. The rays acting through the celluloid, caused a slight redness on the skin. Two or three weeks later the redness increased and inflammation set in. The skin finally sloughed off.

M. Curie has repeated on himself the experiment of M. Giesel, causing radiferous barium chloride to act on his hand, through a thin sheath of gutta-percha, for ten hours. The activity of this substance was comparatively feeble (the activity was 5,000 times that of the metallic uranium). After the action of the rays a surface of six centimeters square of the skin became red; the appearance was that of a burn, but there was scarcely any pain. In a few days the redness, without extending, began to increase in intensity; on the twentieth day crusts were formed, ending with a sore which required dressing. On the forty-second day the epidermis commenced to form again on the edges, extending to the center, and fifty-two days after the action of the rays a surface of one square centimeter still remains sore and has a grayish appearance, indicating a deeper affection.

M. Henri Becquerel, on carrying a small sealed tube containing a few decigrammes of very active radiferous barium chloride (activity 800,000 times that of uranium†), underwent an experience of the same kind. The matter inclosed in the glass tube occupied a cylindrical volume of from 10 to 15 millimeters by 3 millimeters in diameter; the tube, wrapped in paper, was kept in a small pasteboard box. On April 3 and 4 this box was placed several times in a corner of a vest pocket for a period of which the total duration amounted to six hours. On April 13 it was perceived that the radiation through the tube, the box and the clothes had produced a red spot on the skin, which became deeper as the time passed, marking in red the oblong form of the tube and assuming an oval form 6 centimeters long by 4 centimeters wide. On April 24 the skin fell off; then the most affected part sank in, beginning to suppurate; oleo-calcareous dressings were applied to the sore for a month, the diseased tissues were removed, and on May 22, that is to say, forty-nine days after the action of the rays, the ulcer closed, leaving a scar which marked the place of the tube.

While care was being given to this burn, there appeared, about May 15, a second oblong red spot opposite the other corner of the vest pocket in which the active matter had been placed. The exposure had been of short duration, an hour at most. Erythema now appeared, thirty-four days at least after the exciting action; inflammation developed, presenting the appearance of a superficial burn; on May 26 the skin began to fall off; on receiving the same care as the first, this burn appeared to be more rapidly cured.

In the interval of these observations, on April 10, 11 and 12, the same tube of active matter, inclosed in a lead tube, whose walls were about 5 millimeters thick, was kept for forty hours in another vest pocket, but has so far been attended with no physiological effect.

It may be added that Mme. Curie, by carrying in a small sealed tube a few centigrammes of the same very active matter which has caused the effects described above, has had similar burns, although the small tube was inclosed in a thin metallic box. In particular, an exposure of less than half an hour produced at the end of fifteen days a red spot, resulting in a blister similar to a superficial scald. Fifteen days were required for the cure.

These facts prove that the duration of the effects varies with the intensity of the active rays and with the duration of the exciting action.

Our hands have been also affected. There has been a general tendency to desquamation, the extremities of the fingers which have held the tubes or capsules containing active products, become hard and very painful. In the case of one of us, the inflammation of the extremities of the fingers lasted about fifteen days, and indeed after the falling off of the skin, the painful sensations have not yet completely passed away at the end of two months.

* From the French of MM. Henri Becquerel and P. Curie. Paper presented to the Academie des Sciences.

† The activities which we mention are those which the measuring apparatus of M. Curie gives. They allow the products to be classed and characterized, but the radiation of the radium is so complex that these results have not absolute value. With another apparatus different numbers were obtained.

CARBURETED WATER GAS.

THE gas industry is again concerned about a discovery which, at its introduction, gave rise to lively controversies; we refer to that of water gas, which at present has both ardent defenders and detractors, just as it had forty years ago. Some regard it as the fuel of the future, which at a not very remote epoch is to realize the prevision of Dr. W. Siemens that gaseous fuels will be almost exclusively employed. Others are of the opinion that the production of it, as compared with that of coal gas, is not as economical as its promoters are wont to assert, and that, on the other hand, the proportion of carbonic oxide (a very poisonous gas) that it contains ought to put municipalities that are disposed to adopt it for public and private lighting on guard.

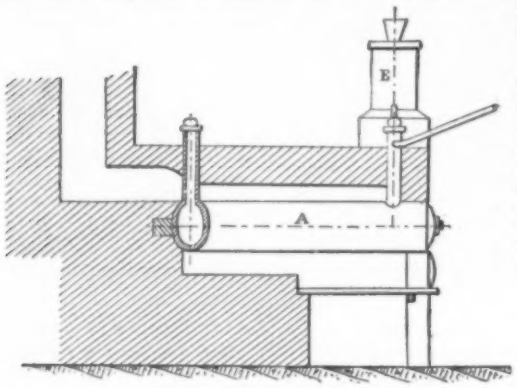


FIG. 1.—VERTICAL SECTION OF THE GENGEMBRE APPARATUS.

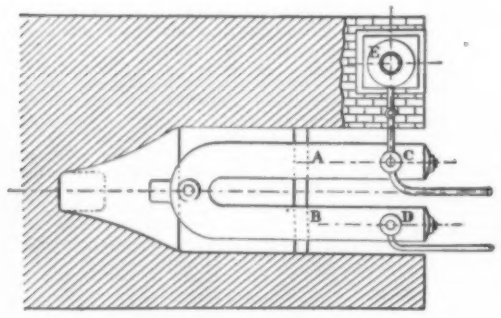


FIG. 2.—THE GENGEMBRE WATER GAS APPARATUS (1819).

As the question offers a genuine interest, it has seemed to us that it would be well to give as faithful a sketch as possible of this industry.

History.—Let us recall in the first place that water gas is obtained by passing steam through incandescent coke or coal. The steam is decomposed and gives a gas formed theoretically of 50 per cent of carbonic oxide and 50 of hydrogen. In practice, this gas contains in addition a little carbonic acid, nitrogen and sulphureted hydrogen.

Water gas burns with a non-luminous flame and possesses no odor. In order to use it for lighting it is therefore necessary to enrich it with oil, benzene, etc., which render it luminous and give it an odor that is as characteristic as that of coal gas.

After the work on the synthesis of water undertaken by Cavendish, Monge, Laplace and Lavoisier, and after the analysis of water made by Lavoisier and Meunier in 1783, the physicist Fontana demonstrated that this liquid is decomposed by its passage over glowing coal. But the first practical application of

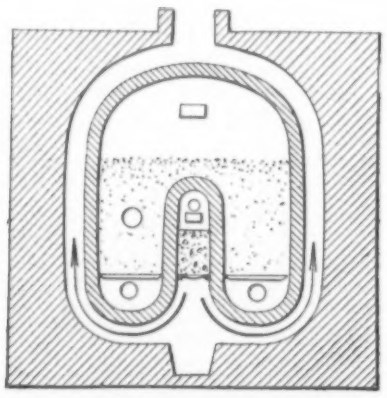


FIG. 3.—SECTION OF THE IBBETSON APPARATUS (1824).

the utilization of the products of such decomposition for lighting seems to be due to Philippe Gengembre and his son Antoine, who, in 1819, constructed an apparatus (Figs. 1 and 2) for producing an illuminating gas composed of water gas enriched by means of oil gas.

A U-shaped cast iron retort, *A B*, was installed in a furnace and charged with charcoal. When the latter was incandescent, there was introduced through the pipe, *C*, a jet of steam produced in a contiguous boiler; but, since the gas produced thereby gave little light of itself, some oil contained in a receptacle, *E*, was allowed to fall, drop by drop, at the very point where the decomposition of the steam began. The gas formed made its exit through a pipe, *D*, and flowed to a condenser.

This application therefore antedates by a few years those of Vere and Crave (1823), of Ibbetson (1824), and of Doudran (1830), who are generally considered as the first introducers of water gas.

The Ibbetson apparatus in particular consisted of a furnace (Fig. 3) in which was inclosed a distillation chamber in the form of a pack-saddle, the two sides of which inclosed a firebox with downwardly directed flames. The flames descended through the fuel and heated the external surface of the distillation chamber, in which the coal to be distilled was confined. After the latter was converted into incandescent coke, steam was brought into contact with it.

The invention of water gas is likewise claimed by Jobard, of Liege, who, with Selligue, in 1833, took out a patent for bringing about the decomposition of water by means of coal heated to redness and contained in cast iron tubes placed vertically in a furnace. Over the coal in the first tube flowed a continuous stream of water, which, on becoming decomposed, yielded carbonic oxide and much hydrogen and carbonic acid. The whole passed into the second tube and became reduced therein to a mixture of carbonic oxide and hydrogen, which entered the third tube along with a stream of mineral oil that fell upon incandescent iron chains. This process was analogous to that which Donovan devised three years later at Dublin.

The Jobard and Selligue apparatus was tried at Belleville, Batignolles and Dijon. The majority of the installations of these inventors were experimented with, with the concurrence of Engineer Grouvelle, who, with one of these apparatus, lighted the prison of Mazas. The question was studied also by Lowe (1831), Leprince (1844), Murdoch (1845), Pollard (1845), and Gillard (1846). The process of the latter, put in practice in 1856, at Narbonne, produced about 353,150 cubic feet of gas in 24 hours. It had been previously tried at Passy and Palma.

Gillard manufactured hydrogen gas, which was utilized in special burners surmounted by a small mantle of platinum wire. The latter, raised to a white heat through the combustion of the hydrogen, gave a very brilliant and steady light. This was the beginning of incandescence by gas.

As the Gillard process was not a success at Narbonne, it was replaced there by the Galy-Cazalat system, which, doing away with the distillation chambers, or continuously heated retorts, stored up in a cupola a quantity of coke that was raised to incandescence through its own combustion. As soon as the desired degree of incandescence was obtained, the draught and communication with the exterior were shut off, and steam was introduced and became decomposed.

White (1847-1849), Barlow and Gore, and J. & T. H. Kirkham (1852), Jacquelain (1854), Fayes (1859), Sanders (1859), and many other investigators occupied themselves successively with the question of water gas, and devised apparatus for rendering the manufacture of it industrial.

We must wait for the time of Tessié du Motay, however, to find a really practical method of manufacturing this gas. His process consisted in the decomposition of steam in the presence of incandescent coal and in the enriching of the gas produced by means of vapor of naphtha. The mixture was afterward rendered permanent by its passage through a gasifier composed of retorts heated to a bright red (Fig. 4). The gas coming from the generator was in the first place received in a small gasometer serving as a regulator, and from the latter passed into a carbureter, then to the gasifier and finally to a purifier.

Finding that France had no use for his invention, Du Motay introduced the application of it into America in 1876-77. Profs. Strong and Lowe completed the primitive apparatus by causing the products of combustion to pass through regenerating chambers called superheaters, and also by heating the outside air before it was drawn into the furnace. Since that epoch the processes of manufacture of water gas have been greatly improved, but it is none the less true that the Du Motay apparatus were the first that permitted of a truly industrial utilization of this gas, the applications of which have very rapidly developed, especially in the United States. In this country, in fact, the conditions are particularly favorable for the production of water gas for illuminating purposes. The country possesses immense deposits of anthracite, which furnishes an excellent fuel for the supply of water-gas works, and the waste from the manufacture of kerosene may be procured at a low price. Such waste is a valuable element for the carburetion of the gas. So, at present, nearly 80 per cent of the illuminating gas distributed consists of carbureted water gas, which is even very commonly utilized in a pure state.

It was not till about 1891 that the first important installation of water gas was created in England, where, in the beginning, the object was merely the enriching of coal gas. Since then, the manufacture of the gas has been carried on with the object of furnishing it in a mixed state. Out of 147,157,605,000 cubic feet made in 1900 in the United Kingdom, 9,994,145,000 were water gas.

In Germany, the first installation organized according to modern principles was that of Frankfort-on-the-Main (1880-1881). Since then, a certain number of large cities, such as Koenigsberg, Bremen, Erfurt, Hamburg, Posen, etc., have been manufacturing in their gas works a mixture of coal gas and carbureted water gas. The movement even seems about to extend, for several central water-gas works are in course of construction in various other German cities (Osterfeld, Ibbenbüren, etc.).

The same is not the case in France, where the manufacture of water gas is entirely neglected.

Mean Composition of Water Gas.—We have already recalled the fact that water gas is obtained by causing steam to pass through a stratum of incandescent coal. This latter, upon becoming decomposed, ought to give, theoretically:

$$C + H_2O = CO + H_2$$

In reality, such is not the case, since the steam reduces the temperature of the coal over which it passes, and the reaction is no longer that given above.

According to experiments made in Germany by M. Harris, under the auspices of Dr. Bunte, the reaction operates at from 600 to 700 degrees, according to the formula:

$$C + 2H_2O = CO_2 + 2H_2.$$

It is only toward 1,000 degrees that the first formula is true. As it is very difficult to keep the gas generator at a temperature of about 1,000 degrees,

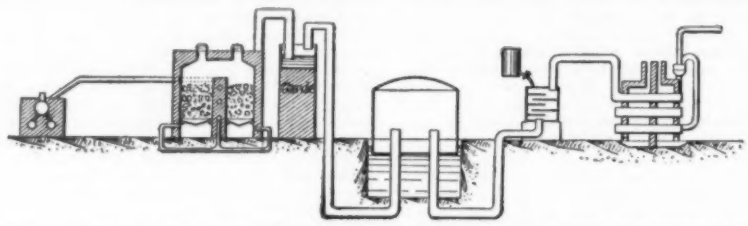


FIG. 4.—INSTALLATION OF TESSIE DU MOTAY, FOR THE INDUSTRIAL MANUFACTURE OF WATER GAS.

water gas necessarily contains carbonic acid. Moreover, as the coke employed almost always contains a little sulphur, sulphureted hydrogen is likewise produced in contact with the hydrogen.

M. Sospisio, in a communication to the International Congress of the Gas Industry, held at Paris in 1900, gives the average composition of water gas industrially produced as

Hydrogen	44.6
Carbonic oxide	45.6
Nitrogen	4.3
Carbonic acid	2.3
Sulphureted hydrogen	1.2
	100.00

Apparatus Now Used for the Production of Water Gas.—In apparatus for the production of water gas, it is necessary, according to what precedes, to keep at a very high temperature the coal used for decomposing the steam. To effect this, there is produced in the interior of the generator a combustion of a portion of the fuel, and this is quickened by a strong current of air. The oxygen of the air is first converted into carbonic acid, and then into carbonic oxide, in contact with the upper layers of the coal. The insufflation of air, which gives rise to air gas or Siemens' gas, constitutes the first phase of the manufacture of water gas. The Siemens gas produced is utilized, according to the apparatus, for the gasification of the carburants of the water gas, for keeping the generator at a high temperature, or for any other heating purpose.

A temperature of nearly 1,000 degrees having been obtained, the current of air is arrested and steam is injected. This is the second phase of the production of water gas—the productive phase.

The apparatus at present used for the manufacture may be divided into two classes:

1. Those that produce water gas only, which is

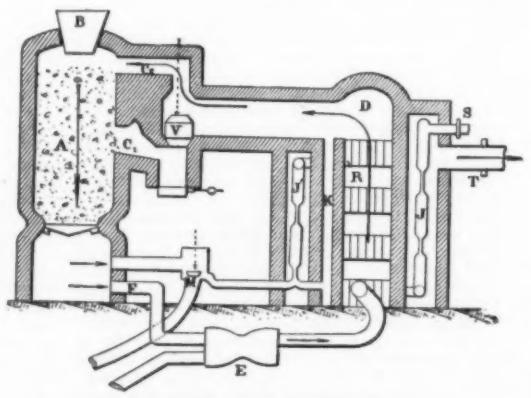


FIG. 5.—LONGITUDINAL SECTION OF A STRACHE GENERATOR.

employed just as manufactured or carbureted separately.

2. Those that directly produce carbureted water gas.

We shall now give a brief description of these apparatus from M. Sospisio's communication above referred to.

The Strache Apparatus.—Dr. Strache, in his generator for the production of water gas, uses soft coal and lignite as well as coke and anthracite. Experiment having shown him that the fuel employed must be freed, as far as possible, from volatile substances, he converts the gas coal or lignite in his apparatus

into coke by means of strongly superheated steam and by the combustion of a part of the water gas itself.

The Strache apparatus (Fig. 5) consists of a generator, *A*, charged with fuel through a hermetically closed hopper, *B;* a regenerator, *R;* and a recuperator, *J J'*. The fuel contained in the generator *A*, having been raised to incandescence, air is introduced under the grate by means of a blower placed at the end of the conduit, *S;* and, in this way, there is obtained air gas, which, through C_1 (the valve, *V*, being raised), enters the generator, *R*, and burns there, combining with the air that enters through the conduit, *K*. The products of combustion traverse *R*, and, before entering the chimney, give up to it the greater part of their heat. The desired temperature having being obtained, the access of air is shut off, and the generator is charged with coal up to the top. The valves, *S* and *T*, having been closed, and the valve, *M*, put in a proper position for the exit of the gas produced, the steam injector, *E*, is set in operation, and this, drawing in a little water gas through the pipe, *F*, sends a mixture of steam and water gas into the recuperator, *R*. This mixture becomes highly heated therein, and, in entering through C_2, heats the coal in the recuperator and afterward causes it to distill. The products of distillation, combined with the steam, continue their route (some of them becoming decomposed and others converted into water gas), and the whole makes its way through the valve, *M*, to the purifier, and thence to the gasometer of the works.

In these apparatus, the injection of air lasts about ten minutes and that of the steam, and, consequently, the production of water gas, five minutes. The air gas produced during the first period is more than sufficient for the heating of the recuperator and generator.

The excess is collected in *T* and used for other purposes.

With small apparatus, Dr. Strache estimates that the volume of air gas produced per pound of fuel is about 64 cubic feet, and that the calorific power utilizable for other purposes is about 450 British heat units per cubic foot of water gas manufactured. The consumption of gas coal per cubic foot of gas produced varies from slightly over ¾ of an ounce to 1 ounce. In large plants it may run as low as ½ an ounce.

The mean composition of the water gas produced by the Strache apparatus is as follows:

Hydrogen	50	per cent.
Carbonic oxide	40	per cent.
Carbonic acid	4	per cent.
Nitrogen	5	per cent.
Sulphureted hydrogen	0.4	per cent.

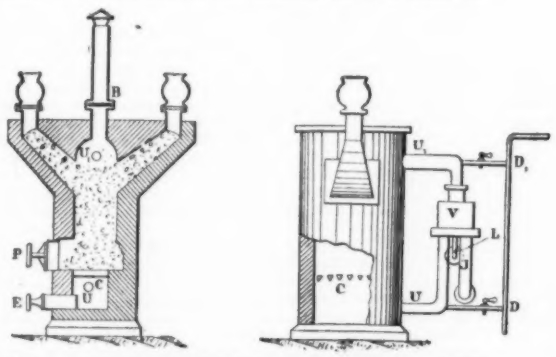
With traces of oxygen, marsh gas and iron carbonyl.

Dr. Strache is an advocate of the use of pure water gas (non-carbureted) for lighting, by utilizing the Auer mantle. The principal hospital of Vienna is thus lighted.

Since pure water gas is odorless, he recommends the introduction into it of something such as mercaptene or carbilamine, in order to give it an odor that may reveal leakages when they occur.

The Dellwick-Fleischer Apparatus.—In the Dellwick-Fleischer process, the insufflation of the air during the first period of the manufacture of the gas is effected in an entirely different manner. Instead of endeavoring to obtain an incomplete combustion in the generator, the inventors try, on the contrary, to convert the coal therein, at once and completely, into carbonic acid by a proper regulation of the draught and the height of the coke. There is thus developed a greater heat in the center of the mass of coke, and an incandescence is consequently more quickly produced. In fact, the combustion of a one-grain molecule of coal converted into carbonic acid permits of obtaining 383,308 British heat units, while, converted into carbonic oxide, it gives only 114,278. Messrs. Dellwick and Fleischer thus retain in their gasometer a large portion of the heat units disposable for the heating of the coal, and increase the quantity of water gas produced per pound of coal introduced.

The apparatus consists of an iron generator provided internally with a lining of refractory material. At first it was provided with two charging hoppers (Figs. 6 and 7) in order to permit of a more rational introduction of fuel, but, in one of the last models (Fig. 8), there is but one hopper. The chimney through which the products of combustion escape is provided with a valve, *B* (Fig. 6). One of the doors, *P*, permits of the removal of the clinkers, and the other, *E*.



FIGS. 6. AND 7.—VERTICAL SECTION AND ELEVATION OF A DELLWICK-FLEISCHER GENERATOR (OLD STYLE).

of the ashes. Two outlets, *U* and U_1, end at the valve, *V* (Fig. 7), which allows the gas produced to pass to the purifier through the pipe, *J*. The steam is introduced either above or below through the pipes, *D* and D_1. The air necessary for the combustion is introduced by means of the pipe, *L*.

The coke in the generator having been raised to incandescence, steam is injected into the lower part of the gas generator, and the water gas is collected through the pipe, U_1. By this fact, the temperature is slightly reduced in the lower part of the apparatus. Then the steam is introduced through D_1 and V_{11} and the gas is collected through *U*. When these two periods are terminated, the valve, *B*, is opened and air is introduced for the heating of the generator.

The period of introduction of the air lasts from a minute to a minute and a quarter, and that of the gasification from eight to ten minutes. The mean

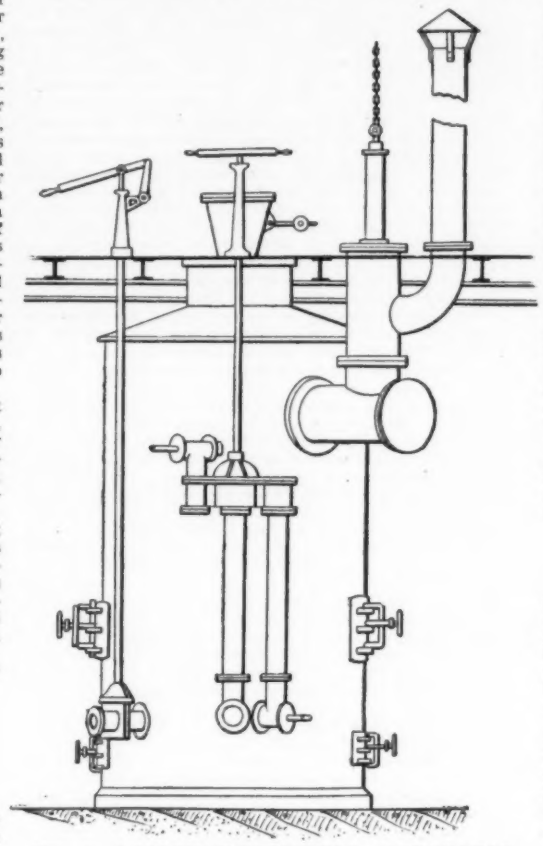


FIG. 8.—DELLWICK-FLEISCHER GENERATOR (1900).

composition of the water gas produced by these apparatus is as follows:

Carbonic acid	4.65	per cent.
Heavy hydrocarbons	0.05	per cent.
Oxygen	0.20	per cent.
Carbonic oxide	39.65	per cent.
Marsh gas	.82	per cent.
Hydrogen	50.80	per cent.
Nitrogen	3.83	per cent.

In these apparatus, it is possible, as at Koenigsberg, to obtain 39.9 cubic feet of gas per pound of coal. The total quantity of steam consumed per cubic foot of water gas at a pressure of 11 pounds, for the generator and the engine, varies from ¾ of an ounce to 1 ounce.

The inventors have likewise studied a gas generator for the production of water gas by means of gas coal or lignite. In this case, the fuel is distilled in the first place upon an inclined dead-plate heated by the products of combustion and converted into coke (Fig. 9).

These apparatus, which have been extensively employed in Germany in recent years, seem to be perfectly adapted for the production of water gas, which is subsequently carbureted with benzene in order to be mixed with coal gas.

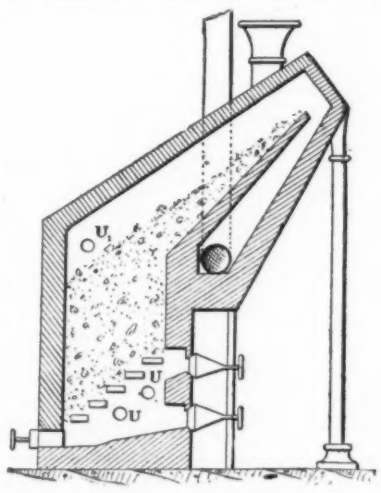


FIG. 9.—DELLWICK APPARATUS FOR THE USE OF LIGNITE.

Carburetion of the Water Gas Produced by the Strache and Dellwick-Fleischer Apparatus.—The gas produced by the apparatus above described must be carbureted before it can be used for lighting. This operation is effected in two different ways, by benzene or by petroleum and the oils of naphtha.

Benzene, obtained from the by-products of coal gas, constitutes an excellent carburant for water gas. It is formed of what are called the rich hydrocarbons of the aromatic series, and consists of a mixture of benzene and toluene, with traces of other light oils. The carburetion with this product is easy. It suffices to allow it to fall drop by drop into a heated apparatus, in which it volatilizes and becomes incorporated with the water gas. The quantity of benzene is regulated according to the proportion that it is desired to obtain. In the carburetion with naphtha, the operation is a little more complicated. The oil gas is produced separately and mixed with the water gas, and incorporated with the latter by passing the mixture through a highly heated apparatus. Messrs. Dellwick and Fleischer use for this purpose cast iron retorts arranged in two rows and connected with each other at the back. These are raised to and kept at a temperature of about 700 degrees. The water gas is introduced at the lower part of the retort along with the naphtha that is to carburet it. The latter volatilizes, and the mixture of the oil gas with the water gas ascends to the upper part of the apparatus, where it is fixed by the effect of the temperature. From the upper retorts, the carbureted gas is sent to the condenser, thence to the cleansers, and finally to the gasometer of the works.

According to Herr Dellwick, it requires 0.59 of a pound of naphtha to carburet the gas of his apparatus, and raise it to an illuminating power of 16 candles. His carbureted gas therefore contains, in volume, 75 per cent of water gas and 25 per cent of oil gas. He estimates the weight of coke necessary for the heating of the carburetion furnace at about 0.001 pound per cubic foot of gas produced.

In order to carburet water gas with the acid of benzene, and raise it to an illuminating power of 16 candles, it requires about from 35 to 38 grains of benzene per cubic foot of gas. Benzene can be procured in France for about $6 per ton.—Le Genie Civil.

SOLAR RADIATION.

SOLAR radiation is a subject which has more than scientific interest. It is the source of all the energy which maintains the economy of our globe. It lights and heats the other members of the planetary system. But, after accomplishing this, only an infinitesimal proportion of the total radiation has been used. The remainder, in so far as we know, is wasted by uninterrupted dissipation into space.

The subject can be regarded and studied from either the solar or the terrestrial point of view. In terrestrial physics everything may be said to depend on the energy which, in one form or another, is supplied by the sun's rays. It is the revenue of the world, and it is of fundamental importance for us to know at what rate it falls to be received.

Roughly speaking, the surface of the earth is occupied to the extent of one-fouth by land and three-fourths by sea. Therefore at least three-fourths of the surface which the earth presents to the sun is at the sea-level. Consequently the rate at which the sun's radiant heat arrives at the sea-level is the fact which it is of the greatest economical importance to ascertain.

In considering this problem we have to answer two questions: What is the best experimental method of determining the heating power of the sun's rays at any place? and, What is the best locality for making the experiment? Let us take the last first. The energy which a radiation communicates to a surface is greatest when it strikes it perpendicularly. At every moment the sun is vertical over one spot or another of the earth's surface. Therefore our first step should be to choose a locality where the sun passes through the zenith at mid-day.

Before reaching the sea-level the sun's rays have to pass through the whole thickness of the atmosphere. It is a matter of every-day observation that the atmosphere varies in transparency. The second condition is therefore to put ourselves in the position of greatest advantage as regards atmospheric conditions. Clouds and similar visible obstructions are of course excluded. The air should be motionless, the sky should be clear and of a deep blue color in the regions remote from the sun and should contain nothing that can be called haze, or that interferes with the definition of the sun or other heavenly bodies.

From inspection alone we can only approximately ascertain what are the most favorable meteorological conditions. For this reason it is necessary to multiply observations and never to miss fine weather. In the end we cannot fail to approach nearer and nearer to the exact determination of the maximum heating power of the sun on the earth's surface at or near the sea-level, in so far as the degree of perfection of our instrumental resources permits. This limitation imposes on us the duty to continue observations, not only until the best natural conditions have been found, but also so long as the instruments or experimental methods appear to be capable of improvement. If we suppose for one moment that we have arrived at the point where no further improvement is possible, then the result of our work is the determination of the rate at which unit area of the earth's surface at or near the sea-level receives heat from the vertical sun in unit time.

There is no question here of how much is lost on the way from the sun. All that is sought, and the most that is ascertained, is how much arrives. If we multiply this by the area included in the great circle of the earth we have the amount of radiant heat which we can count on as being supplied to the whole earth in unit of time. That is the constant which is of greatest importance in physical geography.

When we have ascertained the supply of radiant heat which reaches the earth's surface, we have to inquire what becomes of it. If the heat were to accumulate the world would become uninhabitable. It cannot be doubted that long ago the earth, in this respect, arrived at a condition of equilibrium which is maintained with very slight oscillations. The fundamental principle of this state of equilibrium is that the heat which the whole earth receives from the sun in the course of a year also leaves it in the course of a year, so that, taking one year with another, the sum of the heat remains the same.

When we study the details of the annual dissipation

of heat we find that the atmosphere, and especially the aqueous vapor in it, performs a very important part. Although practically transparent to the heat-rays passing from the sun to the earth, it is very opaque to those leaving the earth to pass outward. They are powerfully absorbed and the temperature of the atmosphere is thus raised considerably above that which it would have if it were as transparent to the leaving rays as it is to the entering ones. This has no effect in permanently detaining any of the year's supply; it still disappears in the year, but not before it has produced important climatic effects.

We see in this differential behavior of the atmosphere toward the incoming and the outgoing rays an example of Kirchoff's law, in virtue of which a body absorbs by preference the rays which it itself emits. It is exceedingly unlikely that any portion of the rays coming directly from the sun proceed from highly heated water or water vapors; we should therefore not expect the water vapor in the atmosphere to absorb them to any appreciable extent. When, however, they strike the surface of the earth, whether it be land or sea, they are abundantly absorbed. The blue water of the ocean transmits the sun's visible rays to a considerable depth. In experiments made by the writer on board the "Challenger," a white surface, about four inches square, was clearly visible at a depth of 25 fathoms. The total length of the path of the incident and reflected ray was 50 fathoms; therefore the sun's rays which strike the sea have a thickness of at least 100 meters to work on. When they strike the land, the direct effect is superficial, but the absorptive power of a surface of soil is very much greater than that of a surface of water, and it frequently attains a very high temperature. Even in the driest countries the soil is moist, and it may be that, ultimately, the surface of every particle of the soil is a water surface. Whether this be so or not, when a land surface cools, the heat of low refrangibility which it radiates proceeds to a very large extent from water, and it is accordingly abundantly absorbed by the water vapor in the lower layers of the atmosphere. In the absence of mechanical mixture by wind, these layers can lose it only by passing it on by radiation to higher layers which contain moisture, whence it ultimately escapes into space. This accumulating function of the atmosphere provides that while every portion of the earth's surface receives heat intermittently it loses it continuously.

As the heat of the atmosphere is due to contact with, or radiation from, the surface, it must be taken from the supply that reaches the surface of the earth. Further, wind and all mechanical atmospheric effects are due to differences of density, and these are produced, not only by the thermal expansion and accompanying rise of temperature of the air, but also, and without change of temperature, by the mixture with it of a lighter gas. Such a gas is the vapor of water, and the water which supplies it is at the level of the sea. Therefore the sun's heat, which arrives at the surface of the earth at or near the sea-level, has to maintain not only the temperature of the surface of the globe, it has also to maintain all the mechanical manifestations of the air and the ocean. This is the ground for asserting, as above, that the only constant which is of interest in terrestrial physics is the rate at which the vertical sun heats unit area of the earth's surface at the sea-level.

The instruments used for measuring the thermal effect of the sun's rays must fulfill certain conditions. The area of the sheaf or bundle of rays collected must be accurately known; and provision must be made for the exact measurement of the thermal effect produced by them in a given time. The thermal effect produced is measured by a mass of some substance and either by the change of temperature produced in it or by the change of its state of aggregation. Actinometers, such as those of Herschel, Pouillet, Violle, Crova, are instruments of the first kind. The ice calorimeter used by Exner and Roentgen and the steam calorimeter of the writer are instruments of the second kind. The thermal mass of the substance affected is conveniently expressed in terms of the thermally equivalent weight of water, which is called its water value. In the actinometer the change of temperature is either measured by a separate thermometer or the actinometer is itself a thermometer, the calorimetric constants of which have been ascertained. In instruments of the second class no thermometer is required; the thermal effect is measured by the mass of water-substance which changes its state in a given time either from ice to water or from water to steam, both being at the same temperature. In the ice calorimeter the quantity of liquefaction is measured by the change of volume, as in Bunsen's calorimeter; in the steam calorimeter the generation of steam is measured by the weight or volume of the distilled water produced. The steam calorimeter was described recently in Nature (vol. lxiii. p. 548), and it is unnecessary to repeat it here. It acted quite satisfactorily in the writer's hands in Egypt in May, 1882, and it has since been giving good results in the hands of Mr. Michie Smith at the observatory of Kodaikanal in South India, at an elevation of about 7,000 feet above the sea. Theoretically, the ice calorimeter is as good as the steam calorimeter, but in applying it to the measurement of the sun's radiant heat it has a practical defect. At the moment before exposure, the ice in the calorimeter is frozen to the inner surface of the metal plate, the outer surface of which receives the sun's rays. The first effect of exposure to the sun is that the ice is detached from the plate. The intervening water introduces perturbations which are not easily allowed for.

The fundamental principle of the actinometer is analogous to Newton's second law of motion; when a body is engaged in the exchange of heat between itself and any number of other bodies, each exchange takes place independently of the others. The rate of exchange in each case depends on the difference of temperature between the two bodies and takes place on the principle that equal fractions of heat are lost or gained in equal times. A body cooling in the air is always subject to at least two quite independent sources of loss of heat, namely, radiation between itself and the surrounding objects and conduction between itself and the contiguous air. In ordinary circumstances the rate of loss of heat by radiation is subject to but little variation, but that due to conduction is subject to continual variation owing to the varying rate at which the air actually in contact with the thermometer is renewed. It is not to be expected that a body subject to at least two independent sources of loss of heat will cool in the same way as it would if exposed to only one, any more than it is to be expected that a body acted on by two forces will move in the same way as if it were impelled by only one of them. The composition of rates of cooling is like that of velocities in the same straight line; the resultant rate is the net, or algebraic, sum of all the rates. When the actinometer is exposed to the sun, its temperature rises at first rapidly, and then more slowly until, if the experiment is sufficiently prolonged, it becomes stationary. The temperature is noted at equal intervals of time. The sun is screened off, either after the temperature has become stationary or beforehand, and the temperature is observed at equal intervals during cooling. Whenever the thermometer is at higher temperature than its inclosure, it is cooling. Therefore when it is exposed to the sun's rays, and its temperature rises ever so little above that of the inclosure, cooling begins; and what is observed in the first operation is, not the rate of heating by the sun's rays, but that rate diminished by the rate at which the thermometer is cooling. Hence, when the two series of observations have been made and tabulated, the rate of rise of temperature when that of the thermometer is, say, 3 deg., 4 deg., or 6 deg. above that of the inclosure is found. Similarly, the rate of fall of temperature when the temperature of the thermometer is 2 deg., 4 deg., or 6 deg. above that of the inclosure during cooling is found. Three pairs of rates are thus obtained. The sums of all three pairs of rates should be alike, and each gives a value of the rate at which the temperature of the actinometer would rise when exposed to the sun if there were no cooling. The rule is the same whether the temperature is allowed to rise to the stationary point or not. A distinction is often made between the *static* method, when the experiment is continued until the stationary temperature is arrived at, and the *kinetic* method, when it is interrupted before that temperature is reached. This distinction rests on no substantial difference; at the same time it is convenient to retain the designations to distinguish the manipulative processes.

Were the protecting inclosures, such as the double spherical shell packed with melting ice, used by Violle, or the thick metal shell used by Crova, perfectly efficient, then it would not be necessary to make a separate cooling experiment in connection with every heating one. The necessity for it is due to the fact that, when the sun's rays are introduced, the temperature of the air in the inclosure no longer is, and it cannot be, at the temperature of the inclosing shell; nor can it remain motionless, as it is when at a constant temperature in the shade. These perturbations, which cannot be avoided, so long as there is air in the inclosure, make it impossible to apply a rate of cooling determined beforehand. It is necessary on each occasion to determine the actual integral rate of cooling during the particular experiment.

If the actinometer be so arranged that the rate of cooling should not be affected by the introduction or exclusion of the sun's rays, the static method could be adopted without hesitation, and the instrument would become a valuable one for continuous self-recording observations. Their value would be mainly relative. The absolute value of the sun's heat radiation, as it reaches the surface of the earth, has to be determined by other means. When it has been ascertained in the most favorable circumstances it does not vary, excepting in the annual cycle of the earth's revolution. The diurnal variation, as shown by registering actinometers, would have a great local importance. Crova, in the long series of valuable observations which he has made since 1875, at Montpelier, has, in fact, put this principle in practice.

Very important observations have been made in the neighborhood of Chamonix by Violle and afterward by Vallot. The Annales de l'Observatoiré météorologique du Mont Blanc contain, in vol. ii., several interesting reports on the results of these observations. They were made simultaneously at Chamonix and at certain stations on Mont Blanc. The first series of observations was made in 1887 on July 28, 29, and 30, and the instruments used were two "absolute actinometers" of Violle (Ann. Chim. Phys. (1879) [5], t. xvii.).

The great advantage of such experiments is that they are made simultaneously at two stations situated at very different altitudes. At the higher of the two the average barometric presure is 430 millimeters, so that 33-76 of the whole atmosphere are below the observer, and this portion contains nearly all the aqueous vapor. Above him there is a little more than one-half, and that much the simpler and purer half of the atmosphere. In it aqueous vapor is almost absent. The summit of Mont Blanc is 4,807 meters and the station at Chamonix is 1,087 meters above the sea. The layer of the atmosphere separating them has, therefore, a thickness of 3,720 meters, and it can be visited at any point in its thickness. M. Vallot has acquired a personal acquaintance with this layer of air, which can only be obtained by devoting a number of years to living in it and observing it. It is this intimate and continuous acquaintance with so large a proportion of the earth's atmosphere that entitles the observations and conclusions of M. Vallot to especially great weight.

The main results of Vallot's observations are as follows: The ratio between the heat received in the same time by the same area exposed perpendicularly to the sun's rays on Mont Blanc and at Chamonix was found to be 0.82 to 0.85, which agreed well with the proportion found by Violle in 1875. The value of the solar radiation found was, however, much lower than that found by Violle. The maximum values observed by Vallot were 1.56 gr. deg. C. on Mont Blanc and 1.33 gr. deg. C. at Chamonix, while Violle found 2.39 gr. deg. C. on Mont Blanc and 2.02 gr. deg. C. at the Glacier des Bossons in the valley. Violle's observed values are therefore half as great again as Vallot's. No explanation of the cause of this discrepancy is offered, but it is pointed out that the values observed by Crova at Montpelier are more in accordance with Vallot's than with Violle's. They are interesting in themselves and are worth quoting. They relate to the year 1895, the summer of which was very hot.

Intensity of solar radiation observed by M. Crova at Montpelier, in 1895, in gramme-degrees per square centimeter per minute.

Season.	Means.				Absolute maxima.	
	Monthly.			Seasonal.		
Winter.....	1.02	1.12	1.15	1.09	1.22	January 28.
Spring	1.20	1.18	1.13	1.15	1.38	May 12.
Summer.....	1.22	1.14	1.10	1..8	1.42	July 24.
Autumn.....	1.30	1.20	1.02	1.17	1.41	September 8.

The subject was taken up again by Vallot in 1891, and this time he used the mercury actinometer of Crova (Ann. Chim. Phys., 1877 [5] xi., 461).

The result of the experiments in 1891 was in the main confirmatory of those obtained in 1887. In the following table the intensities of solar radiation on September 19, 1891, are given as observed on Mont Blanc and at Chamonix:

Hour.		9 a.m.	10.	11.	Noon.	1 p.m.	2.	3.
Observed Radiation.	On Mont Blanc	1.34	1.30	1.36	1.38	1.34	1.33	1.31
	At Chamonix	1.11	1.16	1.19	1.15	1.16	1.09	1.01
Ratio of intensities.		0.83	0.89	0.87	0.83	0.87	0.82	0.77

The mean value of the ratio of the intensities is 0.84, as before. The values of the intensity of radiation are rather lower than those found in 1887.

In the year 1896 Prof. Angström, of Upsala, made observations on the peak of Teneriffe with a special form of actinometer depending on the heating of metal plates. He made observations at three different elevations, namely, at Guimar, 360 meters, Cañada, 2,125 meters, and at the summit, 3,683 meters. Reduced to a uniform thickness of one atmosphere corresponding to a pressure of 760 mm., the intensity of radiation by the vertical sun was found to be at Guimar 1.39, at Cañada 1.51, and at the summit 1.54 gramme-degrees per square centimeter per minute. These values agree more closely with the values found in 1887 by Vallot than with those of 1891. But the values found by Crova, Vallot, and Angström are all of the same order.

The writer's observations with the steam calorimeter in Egypt in May, 1882, were undertaken with the object of ascertaining the maximum rate of distillation near the sea-level under the most favorable circumstances. This occurred during the forenoon of May 18, when the meteorological conditions were as favorable as they could be. The sun shone steadily in a cloudless sky, and the air was motionless. The shade temperature reached 40.5 deg. C. in the course of the day. Time was taken as portions of 5 cubic centimeters were distilled. The shortest time in which this quantity passed was 3m. 20s. This is at the rate of 1.5 c.c. per minute, and it occurred twice in the forenoon, namely, at 10h. 37m. and at 11h. 23m. As the collecting area of the reflector was 904 square centimeters, this corresponds to 16.6 c.c. distilled per minute per square meter. If we apply a correction for 20 deg. zenith distance it becomes 17.04 c.c. The evaporation of 17.04 grammes of water at 100 deg. C. requires 9,116 gr. deg. C. of heat, so that the heat actually collected and used in making steam was at the rate of 9,116 gr. deg. C. per square meter or 0.9116 gr. deg. C. per square centimeter per minute. Converting 9,116 gr. deg. C. into work at the rate of 0.425 kilogramme-meter per gramme-degree, we obtain as the realized working value 3,875 kilogramme-meters per minute or 0.87 horse power per square meter. The reflector consists of one mirror inclined at an angle of 45 deg. to the axis of the instrument. This mirror throws all the reflected rays normally on the surface of the axial boiler. The larger mirror outside and the smaller mirror inside of this one throw their reflected rays inclined at small angles to the normal. Taking all the reflected rays together their mean normal component is 94 per cent of the total reflected rays. It is therefore legitimate to increase the above figures in the proportion of 94 : 100, giving 0.93 horse power or 9,700 gr. deg. C. per square meter per minute. The mirrors are not perfectly reflecting; nor is the blackened surface of the boiler perfectly absorbing. An allowance of 7 per cent for these deficiencies will not be thought extravagant, and we have in round numbers the work value of the sun's vertical rays on the surface of the earth at or near the sea-level as 1 horse power per square meter; the equivalent of this in heat is 10,300 gr. deg. C. per square meter per minute, or 1.03 gr. deg. C., taking the square centimeter as the unit of area.

Mr. Michie Smith informs the writer that the highest rate which he has observed is 1.754 c.c. distilled per minute at a height of 7,000 feet above the sea. This is exactly seven-sixths of the maximum rate observed on the banks of the Nile. If we imagine that in the most favorable circumstances the radiation as determined in Egypt might be improved in this proportion we get 1.17 horse power per square meter and 1.202 gr. deg. C. per square centimeter per minute as a value of the heating power of the sun at the sea-level, which is probably very near the truth.

Comparing these results with those already quoted, we see that they agree with Crova's summer values as determined at Montpelier and lie midway between Vallot's (1891) values for Mont Blanc and Chamonix. We arrive therefore at the conclusion that the rate at which the surface of the earth at the level of the sea receives heat in the most favorable circumstances from the vertical sun is 1.2 gr. deg. C. per square centimeter per minute, or 1.17 horse power per square meter. In discussing questions of terrestrial physics it would not be prudent to postulate a more abundant supply.

If we ascribe to the atmosphere a coefficient of trans-

mission no greater than two-thirds, the value of the *solar constant*, or the heating power which the sun's rays would exert on a surface of one square centimeter exposed to them for one minute at a point on the earth's orbit, is 1.8 gr. deg. C. As the transmission coefficient is probably greater than two-thirds, the value of the solar constant is probably less than 1.8. Vallot, by giving effect to the rate of absorption actually observed in the air separating his two stations, arrives at 1.7 gr. deg. C. as the most probable value. These values are in substantial agreement with the older ones, such as those of Herschel and Pouillet; but there is a feeling at present that not much weight is to be attached to these results, and much higher figures seem to be more readily accepted. In a recent work, "Strahlung und Temperatur der Sonne," p. 38, J. Scheiner sums up the discussion of this subject by giving 4 as the most probable value of the solar constant.

As we have seen, the heat which arrives at the sea-level has to support the temperature of the land and that of the sea; it has also to supply the energy for all the movements of the ocean; it has to warm and expand the air, and to furnish the latent heat represented by the aqueous vapor in the atmosphere, and it is mainly accountable for winds and storms. All this is maintained on less than 1.5 gr. deg. C. per square centimeter per minute. But when the above catalogue of functions has been repeated, there is nothing left to be accounted for. If the sun's rays enter at the top of the atmosphere with an intensity of 4 and come out at the bottom of it with an intensity of only 1.5, how is the loss to be accounted for? It represents nearly double the energy which reaches the sea-level and produces such far-reaching effects. If it really entered the atmosphere it must still be there, either as heat or its equivalent. But we know that the air is not made appreciably warmer by it, and we see no mechanical manifestations which can in any way be put forward as an equivalent. We conclude therefore that there is no excess of heat of this order to be accounted for, consequently values of the solar constant of the order of 4 are exaggerated.

J. Y. BUCHANAN.

THE CHEMISTRY OF PRODUCER GAS.

IT has long been known that at certain temperatures carbonic acid gas in contact with carbon is unstable, and, taking up an additional atom of carbon, becomes carbon monoxide, says Engineering. It is less generally known that the latter gas is also unstable under certain conditions, reverting to CO_2 with deposition of carbon. These cases of dissociation and combination have recently been carefully studied by M. O. Boudouard, who, in a recent issue of the Bulletin of the Paris Chemical Society, discusses the bearing of his researches on the metallurgical industries. He has ascertained in what proportions the two gases form stable mixtures at different temperatures when in contact with fuel, and claims that a comparison of his results with analyses of producer gas will, in any case, give useful information as to the working of the apparatus. His results show the maximum proportion of carbon monoxide which can be obtained with a producer working at a given temperature. These maximum results are in practice never attained. The ideal producer should yield merely CO and N in the proportion of 24.3 volumes of CO to 65.6 of N. Owing to dissociation of the CO, the gas in practice always contains CO_2, and in greater proportion as the working temperature is lower. In fact, the conditions of working can be so arranged that the whole of the carbon is obtained as CO_2. For instance, a high velocity of the air through the furnace is favorable to the production of CO_2, since insufficient time is given for its reduction, after formation, to CO by taking up more carbon. A porous and finely-divided fuel, on the other hand, promotes a good yield of CO, as does also a high temperature of working. In laboratory experiments it was found that in passing CO_2 over carbon at the temperatures noted below, the following proportions of CO were obtained:

Deg. Cent.	Per cent of CO.
600	23
700	58
800	93
900	96.5
1000	99.3

Thus, at 1000 deg. the CO_2 is practically completely broken up, but producers never work at so high a temperature, and hence always give a certain proportion of CO_2. In actual practice the gases are, of course, largely diluted with nitrogen, which makes a longer time necessary for the establishment of equilibrium. Similarly, the kind of fuel used is of importance. Equilibrium is established pretty quickly when wood carbon is used, but with coke, and, above all, bone carbon, the stable state is not reached after several hours' heating at 800 deg. C. Summing up, to get a good yield from a producer, the air current through the furnace should be slow, the temperature high, and the combustible porous and finely divided. In blast-furnaces the carbon monoxide is formed in the hottest part of the furnace, near the tuyeres, since here the temperature is too great for CO_2 to exist. This CO, proceeding upward through the furnace, picks up oxygen from the ore, forming CO_2, and then, meting with glowing carbon, is again partially reduced to CO. If the quantity of this latter gas produced in the neighborhood of the tuyeres is already sufficient to reduce the ore, this second production of CO constitutes a useless loss of heat. Hence, within limits, the loss of heat through the comparatively thin walls of the upper portion of the furnace may be made up for by the lessened production of CO in this portion of the furnace, following the reduction of the temperature consequent on the loss of heat. Again, the less the time the CO_2 is in contact with the hot fuel the less the carbon monoxide formed; hence high air pressures should be used with high furnaces, though too great a rate of flow of the air may prevent the proper reduction of the ore. The fuel should also be in as large pieces as possible, so as to expose a small surface to the carbon dioxide.

THE ELECTRIC LIGHTING INDUSTRY OF THE UNITED STATES.

THE question has often been asked: "How much is represented by the electric lighting industry, and how does this industry compare with other large directions of endeavor in capital invested, people employed, dividends earned, and general importance as a branch of the commercial activity of the country?"

In endeavoring to give an answer to this complex question it has been necessary to make a careful study of the data obtainable from all directions and to compile, as accurately as the circumstances permit, a table setting forth the features of the electric lighting industry which are of the most importance—the number of plants, their situation geographically, and the amount of invested capital represented by these undertakings. The table shown on this page represents the maximum of information obtainable in this direction to-day, and is complete up to September 1, 1901. On account of the impossibility of obtaining information regarding certain features, however, it may be said that the figures given are below the actual facts, both as regards the number of stations and the total of invested capital. It is believed that the number of stations given is very nearly correct, while it is possible that the figures for capital invested are as much as 10 per cent low. The reason of this is that it has not been possible to obtain reports from all the stations in the United States concerning the amount of their outstanding securities.

TABLE OF THE ELECTRIC LIGHTING INDUSTRY IN THE UNITED STATES.

State.	Stations.	Capital.
Alabama	23	$2,372,500
Arizona	9	836,500
Arkansas	28	2,100,000
California	93	50,192,975
Colorado	45	19,705,000
Connecticut	39	21,384,000
Delaware	7	499,000
District of Columbia	2	2,000,000
Florida	17	1,073,000
Georgia	37	2,132,000
Idaho	12	275,000
Illinois	258	30,156,550
Indiana	134	11,525,507
Indian Territory	4	73,500
Iowa	146	7,496,200
Kansas	53	2,947,500
Kentucky	43	6,172,800
Louisiana	15	2,259,400
Maine	47	5,113,100
Maryland	28	3,700,500
Massachusetts	101	45,375,000
Michigan	147	10,558,745
Minnesota	104	7,884,150
Mississippi	20	1,879,000
Missouri	103	25,472,520
Montana	21	2,259,400
Nebraska	32	2,480,900
Nevada	4	360,000
New Hampshire	40	4,632,015
New Jersey	62	64,429,000
New Mexico	5	255,000
New York	204	102,056,000
North Carolina	33	2,305,200
North Dakota	11	542,000
Ohio	188	21,879,700
Oklahoma	6	395,000
Oregon	31	5,164,950
Pennsylvania	228	110,008,000
Rhode Island	12	4,708,000
South Carolina	19	5,106,000
South Dakota	20	804,000
Tennessee	40	2,533,300
Texas	97	3,968,400
Utah	8	23,106,000
Vermont	37	1,500,300
Virginia	40	9,906,500
Washington	38	12,962,300
West Virginia	33	1,711,300
Wisconsin	93	22,685,600
Wyoming	9	927,000
United States	2,842	$668,830,312

In counting the number of stations isolated plants of all sorts were absolutely neglected, and the stations given in the total, 2,842 in number, represent only those actually doing business in public electricity supply in the United States. Under "Capital" in the table the sums given include the outstanding stocks and bonds of the various corporations. While a total of more than $668,000,000 is shown, of course, no one familiar with the field of electrical enterprise in this country will assume that this represents the actual sum in cash expended in the equipment of the stations. It is probable, however, that the total amount of cash money actually expended in the construction of electric light plants as represented in this table is between three hundred and four hundred million dollars.

No accurate figures have been obtainable as to the number of people employed or the salaries paid, nor is it possible to obtain any figures from a sufficient number of stations concerning their earning capacity to make the tabulation of these results of any importance.

A study of the table discovers some very curious conditions. The largest number of separate electric light stations in any State is found in Illinois, while the largest capital invested is in Pennsylvania, which also possesses the second largest number of stations. Where consolidation has been active the number of stations is comparatively small with reference to the total capitalization. For example, California, with only ninety-three stations, shows a capitalization of nearly two and one-half times as much as Ohio, with 188 stations or over twice as many. Probably this is due in some measure to over-capitalization in the Western State, and also to the fact that companies there control larger territory and by the liberal use of power transmission make one station serve a considerable area. In certain regions, again, it is noticeable that capitalization is evidently held within close bounds, as in the District of Columbia, where the capitalization is reported as only $2,000,000 for the fine electric lighting plants of the national capital.

The table represents the fruit of no inconsiderable work and is believed to be as accurate as any that can be produced in the present condition of the industry in this country. One fact is sufficiently evident, however, from it, and that is that electric lighting ranks among the foremost industries of the country in the amount of capital employed and its general importance as a department of industrial endeavor.—The Electrical Review.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Petroleum for Greece.—The following is taken from the press of Athens, under date of October 23, 1901:

"The Department of Finance has given an order to the house of Ralli Brothers, New York, to send at once a cargo of 70,000 cases of petroleum, and an additional one of 2,400 cases for Government lighthouses and beacons. The Department has canceled the order placed with Russia, inasmuch as it is known that the petroleum ordered was not of good quality."

The above statement needs no comment beyond the fact that the order is to be considered larger than usual, in view of the rather recent landing of some 20,000 cases at this port, the distributing center for the north of the Peloponnesus and the Ionian islands, except Corfu. By way of explanation, I may add that these cases each contain two 5-gallon tins, and weigh 65 pounds net. The order placed, therefore, represents a net weight of 4,706,000 pounds, and a quantity equal to 720,000 gallons.—F. W. Jackson, Consul at Patras.

New Coal Mine at Trivieres, Belgium.—Consul Roosevelt writes from Brussels, October 23, 1901:

A new coal mine situated in the hamlet of Quesnoy, at Trivières, in this consular district, was opened on October 20, 1901. This new mine, upon which several millions of francs have been expended, is composed of two pits, sunk at a distance of 43 meters (142.04 feet) apart. The rapidity with which these pits were sunk is said to be without precedent in the annals of mines. The first shaft was commenced on full level ground February 23, 1899, and terminated early in December, 1900, on reaching coal. Work on the second pit was started August 22, 1900, and reached the proper depth February 16, 1901. The system employed in sinking the shafts was very nearly identical with the Kind-Chaudron method, and consisted in the suppression of small pits, which necessitated a peculiar kind of mud and refuse dredging. The surface installations are most extensive. About 1,000 workmen will be employed in the interior of the pits, and the extraction is expected to reach 900 to 1,000 tons of coal per day.

Germany's Colonial School.—Under date of October 22, 1901, Consular Agent Harris writes from Elbenstock:

Within the past two years the German colonial school at Wilhelmshof, in Witzenhausen, has educated and sent twenty-five young men to German East and Southwest Africa, Kameroon, Togo, South Sea Islands, Ecuador, Brazil, Philippines, Cape Colony, and Sumatra. The course of study given in this school is as follows: History, colonial economics, commercial politics, chemistry, botany, geology, natural history, tropical climates, tropical agriculture, bookkeeping, and gardening, with special attention to raising vegetables, fruit and vines, and forestry. A chemical laboratory, a blacksmith, a locksmith, a cabinet-making, and other departments have been arranged, where work is practised as taught.

New Process of Glazing Crockery.—Under date of October 30, 1901, Consul Bergh, of Gothenburg, reports:

The newspapers here report that the English government has recently enacted a law prohibiting the use of poisonous white lead glazing in the crockery industry. It is further said that this has brought forth protests from a number of English manufacturers, who consider the law nearly impossible to comply with. The Rörstrand Porcelain Factory in Sweden and a factory in Dresden, Germany, have, however, solved this important technical problem by mixing the white lead in the glazing with certain substances converting the lead into an insoluble—and thus harmless—silicate of lead. The English government has sent a chemist to study the new method.

Harbor Improvements in the Canary Islands.—Consul Berliner, of Teneriffe, on October 14, 1901, reports that the Spanish government, on October 2, approved an appropriation of 1,102,915 pesetas (about $165,000) for building and improving the mole and breakwater, and providing for the storage of water at Arecife, the capital of the island of Lanzarote, Canary Islands. These improvements, says the consul, will increase the trade and shipping, which had fallen off on account of lack of harbor facilities.

American Warehouse in Shanghai Closed.—Under date of October 15, 1901, Consul-General Goodnow sends from Shanghai printed notice of the discontinuance of the exposition of American manufactures maintained by the National Association of Manufacturers and known as "The American Warehouse in Shanghai."

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1198. November 25. *American Locomotives in Bavaria—Baggage of Diplomatic Officers in Mexico.

No. 1199. November 26.—American Locomotives in France—Influence of American Coal on the International Market—Approximate Production of Sugar for 1901.

No. 1200. November 27.—Oils and Oil Seeds at Marseilles—American Cotton Goods in Turkey—French Colonial Trade.

No. 1201. November 29.—Tariff of Australia.

No. 1202. November 30.—*Advertising American Farm Machinery in Greece—*American Petroleum for Greece—*Packing for Asia Minor—Gold Standard in Peru—Antwerp Ivory Market.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Ruble's Recipe.—Moisten zinc oxide in a Hessian crucible with nitric acid and calcine. The very solid zinc oxide thus obtained is ground very finely and made into a kneadable mass with zinc chloride solution ($ZnCl_2$) of 1.9 to 2 specific gravity; this mass hardens in a few minutes and excels in great permanency.

Production of Dental Cements.—There are two kinds of dental cements, viz., zinc chloride cements and phosphate zinc cements. The former are the oldest. They are all powders of various descriptions giving a stone-like mass upon admixture of various liquids. In the case of zinc chloride cements, the powder consists of zinc chloride and glass, the liquid being zinc chloride; glass powder is equally well adapted for both.

Fairthorne's Cement.—

Powdered glass	5 parts.
Powdered borax	4 parts.
Silicic acid (SiO_2)	8 parts
Zinc oxide	200 parts.

Powder very finely and mix; then tint with a small quantity of golden ocher or manganese. The compound, mixed before use with concentrated, sirupy zinc chloride solution, soon becomes as hard as marble and constitutes a very durable tooth cement.

Rostaing's Formula.—First mix intimately 3 kilos of zinc oxide with 5 to 50 grammes of boracic acid dissolved in water, and heat several hours to white heat, after drying. After cooling there will be found in the crucible an enamel of the hardness of stone and of bluish or greenish color. Same is rubbed up into a coarse sand and roasted in the air, which causes it to turn white. By heating with metallic salts any desired shade may be imparted to the enamel. The enamel powdered into a fine dust is prepared, for use, with a sirupy solution which is obtained by melting together in a crucible a mixture of calcium phosphate and zinc phosphate, dissolving the vitreous mass obtained thereby in diluted phosphoric acid and boiling down the liquid to the consistency of sirup.

An analogous recipe is the following:

Melt in a crucible an intimate mixture of 1 part of secondary calcium phosphate ($Ca HPO_4$) with 15 parts of pure zinc oxide and 16½ parts of secondary ammonium phosphate ($(NH_4)_2 HPO_4$), until the mixture flows quietly and uniformly. The molten mass when cooled is powdered and dissolved in diluted phosphoric acid, and cadmium oxide to the extent of 5 per cent of the molten mass obtained is added; when this is dissolved, evaporate to the consistency of sirup.

Furthermore, knead a mixture of 2,500 parts of zinc oxide and 500 parts of magnesia with 50 grammes of boracic acid dissolved in water, into a stiff paste, dry, and calcine in a Hessian crucible for some hours at white heat. The greenish mass obtained is finely pulverized and roasted in the air, until it turns white, and may be tinted as desired with manganese peroxide or ocher. The resultant powder is made into a paste with the solution above described and furnishes a very firm cement.

According to another recipe, zinc-lime-phosphoric acid solution is prepared as above indicated; then precipitate zinc silicate by mixing a diluted waterglass solution with zinc chloride, gather the precipitate on a filter, wash it well, dry and melt in the crucible. After cooling, powder. Thirdly, calcine zinc oxide for several hours at white heat and intimately mix the finely pulverized oxide with 5 per cent of melted zinc silicate. This mixture is mingled, for use, with 10 to 30 per cent of the solution mentioned and gives a very hard dental cement, which solidifies with heating.—Pharmaceutische Zeitung.

Huebner's Cement.—

Zinc oxide	500.0 parts.
Powdered manganese	1.5 parts.
Yellow ocher, powdered	1.5-4.0 parts.
Powdered borax	10.0 parts.
Powdered glass	100.0 parts.

As grinding liquid it is well to use exclusively acid-free zinc chloride, which one may prepare one's self by dissolving pure zinc, free from iron, in concentrated, pure hydrochloric acid, in such a manner that zinc is always in excess. When no more hydrogen is evolved, the zinc in excess is still left in the solution for some time. The latter is filtered and boiled down to the consistency of sirup.

Commercial zinc oxide cannot be employed without previous treatment, because it is too loose; the denser it is the better is it adapted for dental cements, and the harder the latter will be. For this reason it is well, in order to obtain a dense product, to stir the commercial pure zinc oxide into a stiff paste with water to which 2 per cent of nitric acid has been added; the paste is dried and heated for some time at white heat in a Hessian crucible.

After cooling the zinc oxide thus obtained is very finely powdered and kept in hermetically-closing vessels, so that it can absorb no carbonic acid. The dental cement prepared with such zinc oxide turns very hard and solidifies with the concentrated zinc chloride solution in a few minutes.

In place of the zinc chloride cements, phosphate-zinc cements are, of late, more and more gaining ground. They all consist, essentially, of zinc oxide and the thickish liquid of meta or pyro-phosphoric acid. Mix pyro and meta-phosphoric acid, or dissolve in ortho-phosphoric acid either pyro-phosphoric acid or meta-phosphoric acid or pyro-phosphoric acid anhydride; the liquid may also contain zinc oxide, dissolved, about 1/20 to 1/10.

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